

ROTIFERA FROM AUSTRALIAN INLAND WATERS IV. COLURELLIDAE (ROTIFERA: MONOGONONTA)

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Summary

KOSTE, W., & SHIEL, R. J. (1989) Rotifera from Australian inland waters. IV. Colurellidae (Rotifera: Monogononta). *Trans. R. Soc. S. Aust.* 113(3), 119-143, 30 November, 1989.

Diagnostic keys are given to genera and species of the rotifer family Colurellidae (*Colurella*, *Squatinnella*, *Lepadella*, *Heterolepadella*) recorded from Australian inland waters. All species are figured and available distribution data and ecological information given. Some widely-distributed taxa not yet recorded from the continent are included.

KEY WORDS: Rotifera, taxonomy, Australia, known species, Colurellidae

Introduction

The monogonont rotifer families considered to date in our revision of the Australian Rotifera (Koste & Shiel 1986b, 1987b, 1989) have included the most common planktonic taxa in Australian inland waters. Here we review the Australian representatives of the family Colurellidae, several genera of which have widely-distributed species in plankton and littoral collections in Australian waters and are considered heleoplankters (*sensu* Hutchinson 1967) rather than accidental incursions, i.e. pseudoplankton (= tychoplankton of Ruttner-Kolisko 1974) (e.g. *Lepadella patella*). In general, however, the Australian representatives of the Colurellidae (*Colurella*, *Squatinnella*, *Lepadella*, *Heterolepadella*) are littoral (epiphytic or epibenthic) in habit. They are encountered commonly in the shallow vegetated areas of billabongs and other wetlands, where diverse macrophyte associations effectively partition the habitat, providing abundant microniches.

Diagnostic keys, brief descriptions and figures of all known Australian representatives of the family are provided to enable identification to species. Some widely distributed taxa not yet recorded from Australia are included. The format follows that of earlier parts; dichotomous keys are followed by individual species' descriptions and known Australian records. Relative abundance is indicated by: "common" (more than 30 widely dispersed records), "uncommon" (10-30 localities), "rare" (<10 records). Brief ecological data are included where available. Early Australian records cited in Shiel & Koste (1979) are not repeated here, nor are the majority of northern hemisphere citations given by Koste (1978), which contains a detailed treatment

of the Rotifera outside Australia. Keys to families are included in Koste & Shiel (1987b).

Family Colurellidae Bartos

Loricata rotifers, the corona in all genera with a membranous cap or semicircular shield (retractible in all except *Squatinnella*); no lateral sulci; *Colurella* and *Paracolurella* with ventral sulcus; trophi malleate; ventral plate with caudal foot-opening or enlarged for basal foot segment; toes slender, sharply pointed. Four genera: *Colurella*, *Lepadella*, *Squatinnella*, *Paracolurella*.

Key to genera of the Family Colurellidae

1. Lorica laterally compressed, with ventral or dorsal and ventral apertures (Fig. 2).....2
Lorica dorso-ventrally flattened, without such apertures.....3
- 2(1). Lorica a single structure, with ventral aperture (Fig. 1).....*Colurella* Bory de St Vincent
Lorica two plates, with dorsal and ventral apertures (Fig. 2:8).....*Paracolurella* Myers (not known from Australia).
- 3(1). Hood or head-shield large, non-retractible (Fig.3).....*Squatinnella* Bory de St Vincent
Hood small, retractible (Fig. 5).....
.....*Lepadella* Bory de St Vincent

Genus *Colurella* Bory de St Vincent

Colurella Bory de St Vincent, 1824, p.203.

One piece lorica, in lateral view oval, egg- or hatchet-shaped (outline of lorica differs according to degree of contraction, particularly ventral margin); anterior lorica margin more or less truncated or rounded; posterior margin rounded, gradually merging into blunt, straight or curved projections, in some cases sharply pointed, offset wing-like extensions of posterior margin (Fig. 1c);

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ventral cuticle between mussel-like lorica borders delicate, membranous, may be distorted in preservative; corona of the *Euchlanis* type (cf. Koste & Shiel 1987b); foot with three or four segments, basal segment mostly pliable and often of indistinct structure; distal foot segment (before toe) with dorsal sensory pore; toes of variable length, species with long toes more compressed laterally; toes separate, however may appear fused as frequently are stuck together; gastric glands mononucleate; trophi malleate; eyeless or with two eyespots, which may or may not be red-pigmented; lateral antennae very conspicuous; male little known and insufficiently described. Resting eggs retained in lorica of parent on death (cf. Fig. 2:3d).

Variability in the described species requires investigation, particularly whether the morphology of different races ("var.") or forms represents

ecotypic variation ["Millieufaktoren" (Hauer 1924)], e.g. the variability in the lorica ends in *C. uncinata* or *C. adriatica*. Ecotypic variation is common in the Australian brachionoids (Koste & Shiel 1987b), and variants are known in the five species of *Colurella* recorded from Australia. It is likely that other species occur here; in view of their small size (most <100 µm) colurellids are easily overlooked in detritus-rich samples.

Key to species of the Genus *Colurella*

- 1. Lorica surface smooth.....2
- Lorica surface with longitudinal furrows or facets.....*C. tessellata* (Glascoff)
- 2(1). Lorica valve (lateral) slender, posteriorly with variable apices.....3
- Lorica valve rounded, plump.....*C. obtusa* (Gosse)

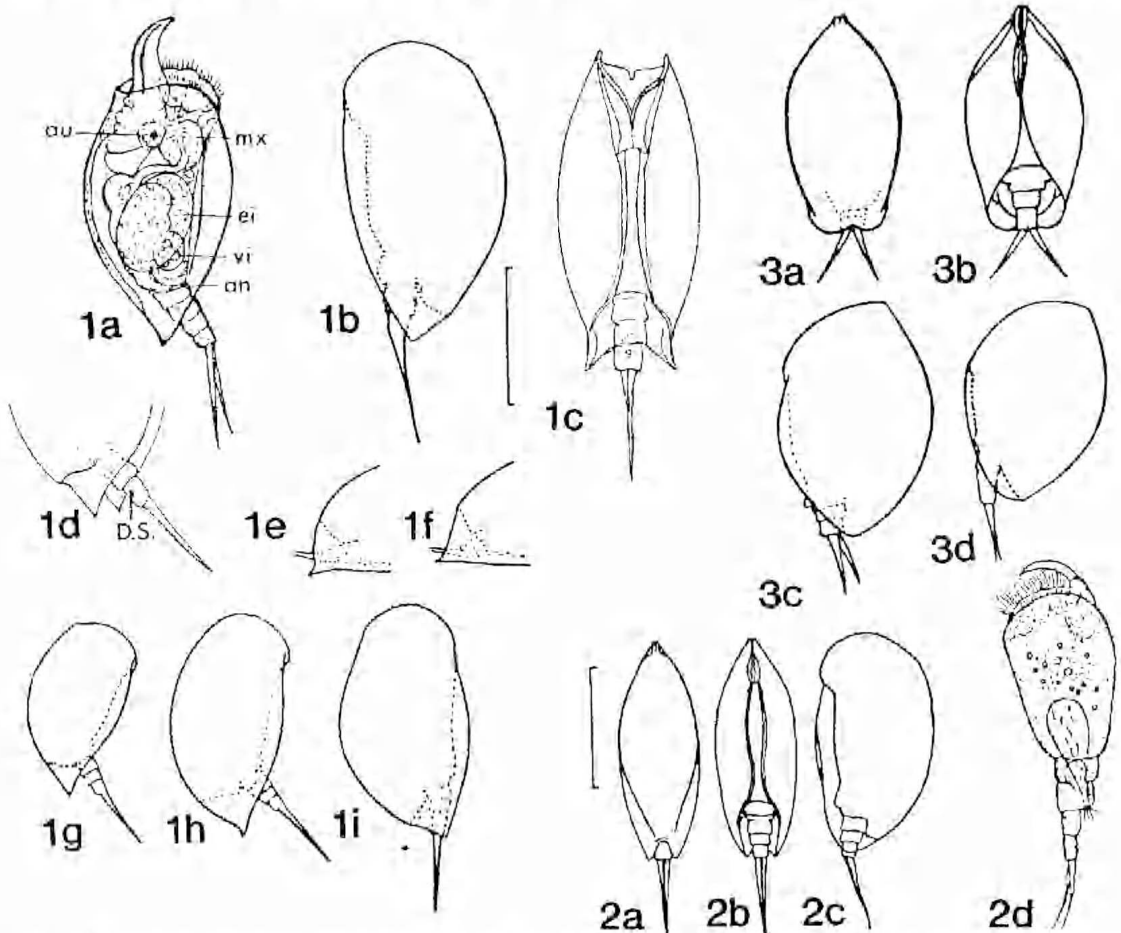


Fig. 1. 1, *Colurella adriatica* (Ehrenberg): (a) lateral (au = anus; an = eye; ei = subitaneous egg; mx = mastax; vr = vitellarium); (b) lateral, contracted; (c) ventral; (d) posterior lorica showing foot and toe (D.S. = dorsal sensory pit); (e-i) lateral views showing variation in lorica morphology. 2, *C. colurus* (Ehrenberg): (a) dorsal; (b) ventral; (c) lateral; (d) male, lateral. 3, *C. obtusa* (Gosse): (a) dorsal; (b) ventral; (c) lateral; (d) another morph, lateral. 1a, after Corda (1838); 1b, 3d, after Carlini (1939); 1c, d, after Wulfert (1950); 1e-i, 2a-c, after Hauer (1925); 2d, after Wszniewski (1953); 3a-c, after Hauer (1924). Scale lines 50 µm.

- 3(2). Posterior end of lorica with raised lines terminating in variable tapering, downward-curving (occasionally lightly upward-curving) spines; lorica high (length/height ratio <1.8); toes short.....
 *C. uncinata* (Müller)
 Posterior end of lorica broadly rounded, or blunt-spined or tapering, lorica low (ratio >1.8); toes long..... 4
 4(3). Lorica valve posteriorly rounded, or at most extended to a blunt apex (Fig. 1:2c).....
 *C. colurus* (Ehrenberg)
 Lorica valve posteriorly with curved spines (Fig. 1:1c)
 *C. adriatica* Ehrenberg

Colurella adriatica Ehrenberg

FIG. 1:1

Colurella adriatica Ehrenberg, 1831, Fig. 3:1.

Diagnosis: Extremely variable lorica size and phenotype, particularly points at posterior end of lorica. These are the only features separating *C. adriatica* from *C. colurus*. Pejler (1962) noted transitional forms. Different ecotypes were described by Hauer (1924), with increased lorica size and toe length correlated with increasing salinity. The measurements below encompass the range of ecotypes (Koste 1978).

Length 85–113 µm; width 29–48 µm; height 44–66 µm; toe length 28–48 µm.

Distribution: Probably cosmopolitan. Euryhaline. Rare: fresh and slightly saline waters of southeast S. Aust., Tas. and western Vic. Berzins (1982) recorded *C. adriatica* as widely distributed in eastern Australia. 5.0–30.0°C, pH 5.5–10.5, dissolved oxygen (DO) 6.0–11.2 mg l⁻¹, conductivity (K₂₅) 57–13,940 µS cm⁻¹ turbidity 21–67 nephelometric turbidity units (NTU).

Literature: Ridder 1972; Koste 1978.

Colurella colurus (Ehrenberg)

FIG. 1:2

Monura colurus Ehrenberg, 1830, p. 44.

Colurella colurus after Harring, 1913, p. 29.

Diagnosis: Distinguished from *C. adriatica* only by the rounded or blunt-spined posterior lorica. Resting egg and male known (Fig. 1:2d).

Length 71–110 µm; width 25–37 µm; height 39–55 µm; toe length 25–40 µm.

Distribution: Cosmopolitan, widely tolerant, occurring in fresh, athalassic saline and coastal waters. European temperature 1.0–28.0°C and pH 4.9–10.0. Ridder (1972) records *C. colurus* from 15,035 g Cl l⁻¹. Rare: Tas., Vic., 11.8–16.0°C, pH 5.7–6.4, 415–2130 µS cm⁻¹.

Literature: Koste 1978.

Colurella obtusa (Gosse)

FIG. 1:3

Colurus obtusus Gosse in Hudson & Gosse, 1886, p. 103, Fig. 26:3.

Colurella obtusa after Hofsten, 1909, p. 84.

Diagnosis: Lorica outline plump; margin of head-aperture directed obliquely from ventral lorica; ventral lines variable; head width approx. half lorica length, or smaller; eyespots with or without pigment.

Length 60 µm; width 28 µm; toes 17 µm.

Distribution: Cosmopolitan between aquatic macrophytes; pancontinental, uncommon, 8.0–29.0°C, pH 3.4–7.5, DO 11.2 mg l⁻¹, 36.4–1600 µS cm⁻¹, 15 NTU.

Literature: Evans 1951; Koste 1978, 1981; Shiel & Koste 1979; Green 1981; Koste *et al.* 1988.

Colurella tessellata (Glascott)

FIG. 2:1

Colurus tessellatus Glascott, 1893, p. 74.

Colurella tessellata after Hofsten, 1909, p. 84.

Diagnosis: Lorica with dorsal keel; facet-like pattern with ribs on lorica surface; toes relatively short.

Length 55–64 µm; width 24–31 µm; height 32–41 µm; toes 18–27 µm.

Distribution: ?Cosmopolitan (not recorded from N.Z.), sporadic in oligotrophic waters, mostly in moss, also in psammon. Single record from Coghills Creek, Tareello, Vic.

Literature: Koste 1978; Berzins 1982.

Colurella uncinata uncinata (Müller)

FIG. 2:2

Brachionus uncinatus Müller, 1773, p. 134.

Colurella uncinata after Harring, 1913, p. 30.

Diagnosis: Lorica posterior end gradually merges into downward-curving short spines; head-opening smaller than greatest lorica height.

Length 77–106 µm; width 30 µm; height to 60 µm; toes 18–23 µm; male 50–85 µm.

Distribution: Cosmopolitan, euryhaline. Common-pancontinental. 8.5–24.5°C, pH 4.8–8.0, DO 7.8–11.2 mg l⁻¹, 20–1600 µS cm⁻¹, 3–160 NTU.

Literature: Koste 1978.

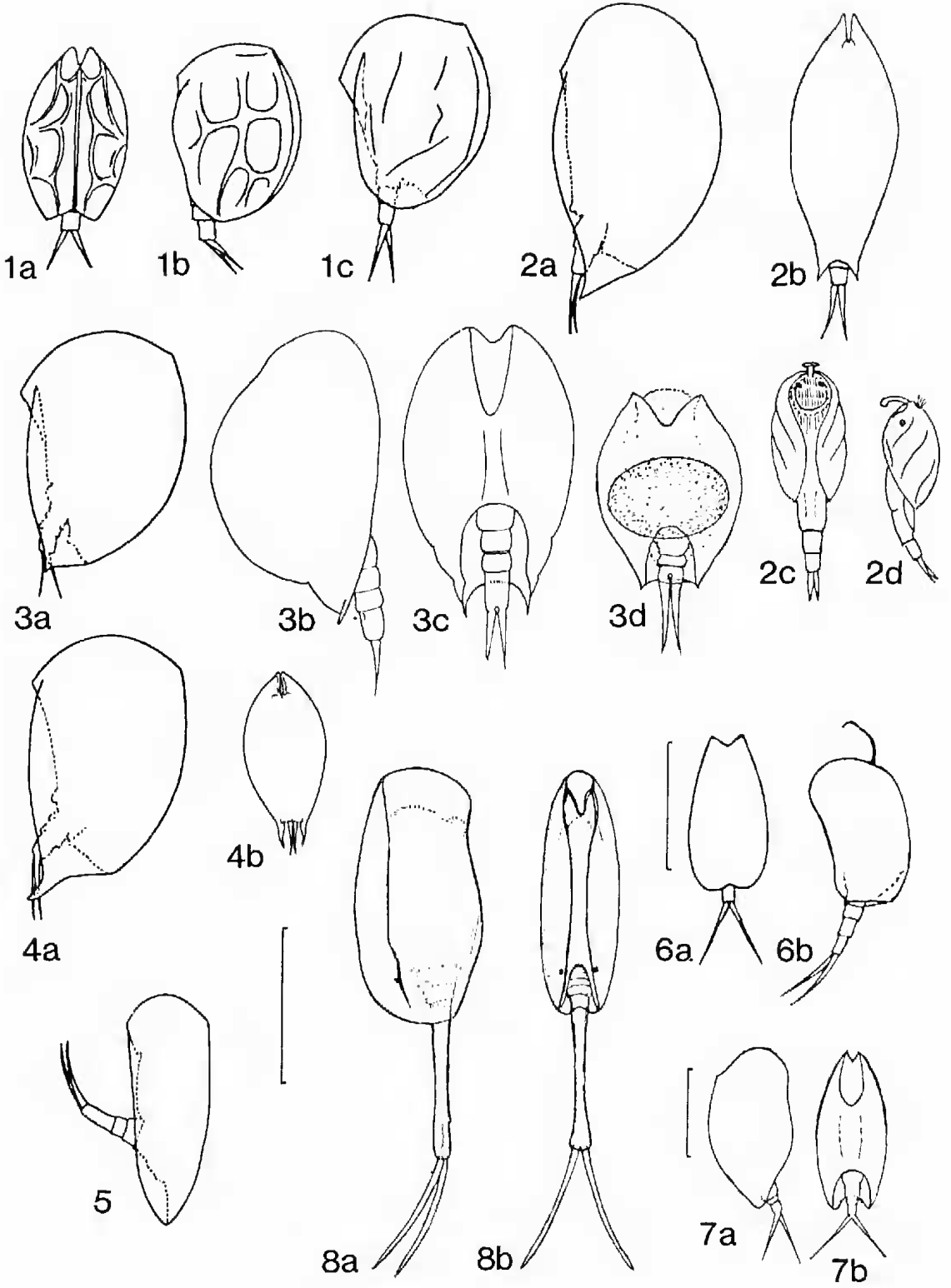
Comments: Two morphologically distinguishable taxa described originally as distinct species, but regarded by Koste (1978) as "form" variants of *C. uncinata* also are known from Australia.

Colurella uncinata bicuspidata (Ehrenberg)

FIG. 2:3

Colurus bicuspidatus Ehrenberg, 1832, p. 129.

Colurella uncinata f. *bicuspidata* after Meuche, 1939, p.



Diagnosis: Lorica width up to twice that of nominate species; highest extension of lorica at head-opening; lorica ends short, most curve downwards; toes relatively short; resting egg with punctiform cavities.

Length 60–108 μm ; width 53–62 μm ; height to 60 μm ; toes 13–27 μm .

Distribution: Cosmopolitan in littoral of fresh and athalassic saline waters, also marine littoral. Uncommon: N.S.W., Qld, S. Austr., Tas., Vic. 10.0–23.5°C, pH 4.5–7.5, 53–927 $\mu\text{S cm}^{-1}$.

Literature: Koste 1978; Shiel & Koste 1979; Green 1981; Berzins 1982.

Colurella uncinata deflexa (Ehrenberg)

FIG. 2:4

Colurus deflexus Ehrenberg, 1834, p. 203.

Colurella uncinata f. *deflexa* after Meuche, 1939, p. 400.

Diagnosis: Lorica end robust, elongated, turned outward, most directed ventrally. Very variable.

Length 60–100 μm ; width to 55 μm ; height 35–55 μm ; toes 17–25 μm .

Distribution: Cosmopolitan, sporadic, euryhaline. Rare: Qld, Tas. 9.5–20.0°C, pH 6.5.

Literature: Shiel & Koste 1979; Koste & Shiel 1987a.

Not recorded from Australia:

C. denticauda Carlin, 1939. Scandinavia

C. dicentra (Gosse, 1887). N. Europe, marine

C. hindenburgi (Steinecke, 1917)(Fig. 2:6). Probably cosmopolitan

C. geophila Donner, 1951. Europe

C. maritimi Althaus, 1957. Black Sea, mesopsammal

C. monodactylos Althaus, 1957. Black Sea

C. mucronulata Ahlstrom, 1938. U.S.A.

C. oblonga Donner, 1943. Europe

C. oxycauda Carlin, 1939. Scandinavia

C. paludosa Carlin, 1939. U.S.S.R.

C. salina Althaus, 1957 (Fig. 2:7). Europe, N.Z.

C. sinistra Carlin, 1939. Europe

C. sulcata (Stenroos, 1898)(Fig. 2:5). Probably cosmopolitan, warm stenotherm, acidophil.

C. unicauda Eriksen, 1968. N. Europe.

Genus *Squatinella* Bory de St Vincent

Squatinella Bory de St Vincent, 1826, p. 87.

Body cylindrical to ovoid; head and corona under hyaline semicircular shield (Fig. 3:1), which is pointed apically in some species, also with

triangular side plates ("ears"); dorsal lorica smooth, also with occasional symmetric longitudinal ribs; ventral lorica smooth, with attached shield-like plate, with one or two scales, or also with keel; posterior lorica rounded, truncated or tapered to variable points; some species with long dorsal spine; short spine in median line of posterior lorica may be present; foot 2- or 3- segmented with long pointed toes; small thin spine may be present at base of toes (Fig. 3:1c); symmetric malleate trophi (Fig. 3:6); gut without peculiarities; dorsal and ventral antennae small; two widely separated distinct eyespots with crystalline bodies. Male and resting egg not yet described. Ecology of *Squatinella* little known. Koste (1978:174) notes genus restricted to littoral, with some spp. acidophils. Four species recorded from Australia. For details of other species and variants, see Koste (1978:175–179).

Key to species of the genus *Squatinella*

1. With dorsal spine 2
- Without dorsal spine 3
- 2(1). Foot 3-segmented; short spine at base of toes *S. longispinata* (Tatam)
- Foot 2-segmented; spine absent *S. leydigii* (Zacharias)
- 3(1). With a short spine above the base of the toes *S. rostrum* (Schmarda)
- Without spine above toe bases *S. mutica* (Ehrenberg)

Squatinella longispinata (Tatam)

FIG. 3:3

Stephanops longispinatus Tatam, 1867, p. 252, Pl. 10, Figs 1–3.

Squatinella longispinata after Harring, 1913, p. 96.

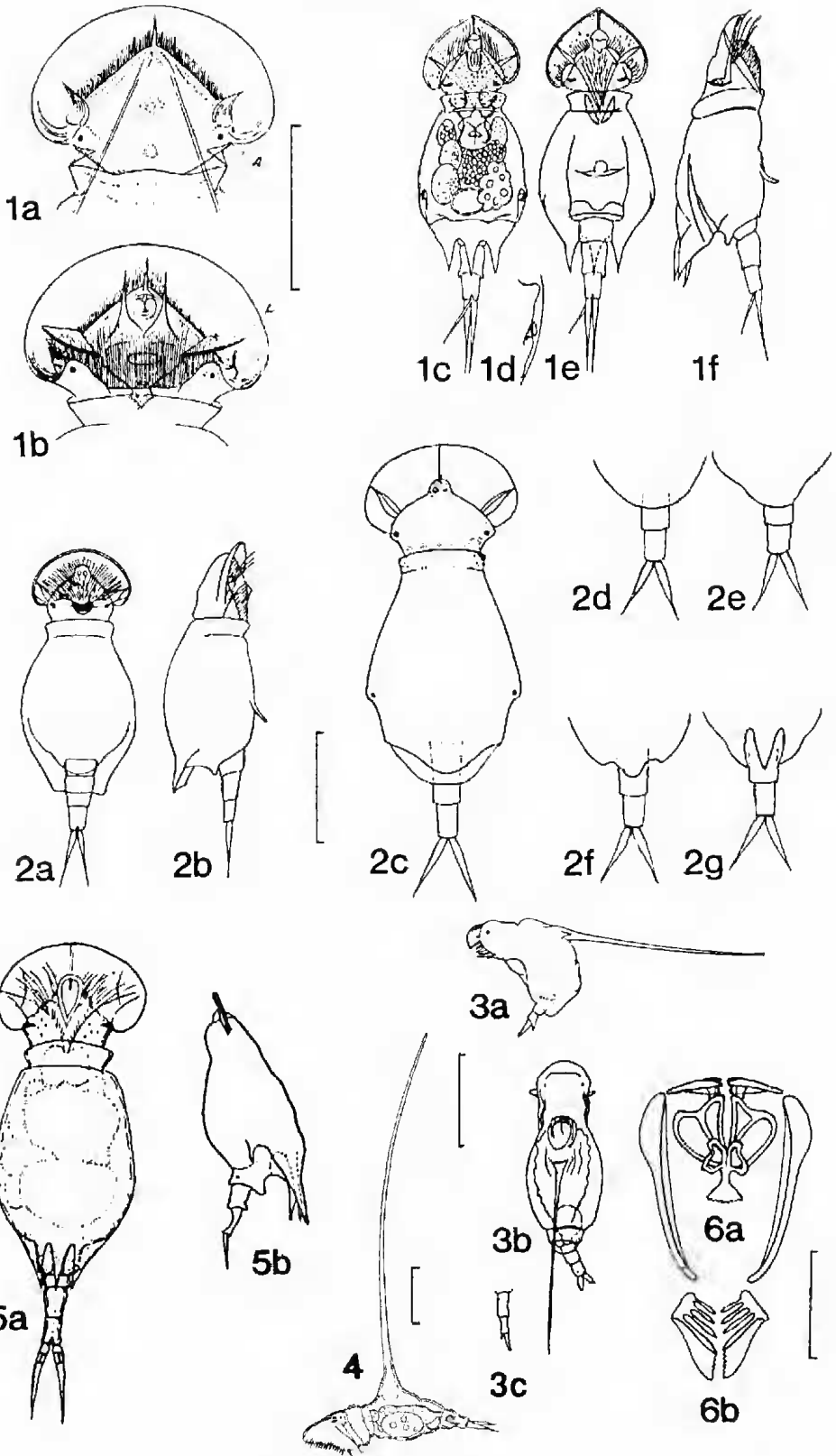
Diagnosis: Characteristic long, thin and curved dorsal spine. Pejler (1962) noted two short spines flanking dorsal spine (Fig. 3:3a). Ventral side sometimes wrinkled. Ratio dorsal spine:body length 0.8. Foot three-segmented.

Length 82–160 μm ; dorsal spine 96–116 μm ; toes 3–10 μm ; spine(s) at the base of the toes 4–5 μm .

Distribution: Widespread but rare, mostly in moor waters between *Sphagnum* (Koste 1978). We have not encountered this species in > 2000 collections, however it was recorded by Whitelegge (1889) from N.S.W., also by Evans (1951) from Victorian waters.

Literature: Pejler 1962; Koste 1978.

Fig. 2:1, *Colurella tessellata* (Glascott): (a) dorsal; (b, c) lateral. 2, *C. uncinata uncinata* (Müller): (a) lateral; (b) dorsal; (c) male, ventral; (d) male, lateral. 3, *C. uncinata bicuspidata* (Ehrenberg): (a) lateral; (b) another morph, lateral; (c) ventral; (d) ventral, with resting egg. 4, *C. uncinata deflexa* (Ehrenberg): (a) lateral; (b) habit, dorsal. 5, *C. sulcata* (Stenroos), lateral. 6, *C. hindenburgi* Steinecke: (a) dorsal; (b) lateral. 7, *C. salina* Althaus: (a) lateral; (b) ventral. 8, *Paracolurella lugina* Myers: (a) lateral; (b) ventral. 1a, b, 2b, 4b, after Hauer (1924); 1c, 2a, 3a-c, 4a, 5, after Carlin (1939); 2c, d, after Weber (1898); 3d, 8a, b, after Koste (1978); 6a, b, after Steinecke (1917); 7a, b, after Althaus (1957). Scale lines 50 μm .



Squatinella leydigii longiseta (Pourriot)

FIG. 3:4

Squatinella leydigii f. *longiseta* Pourriot, 1971, pp. 99–100.
Fig. 3.

Diagnosis: Robust body; dorsal spine longer than body; two foot segments; no spine on distal end of terminal segment (at base of toes). Much larger animal than *S. longispinata*.

Body length 210–235 μm ; dorsal spine 270–378 μm ; ratio spine:body length 1.6; toes to 37 μm .

Distribution: Rare in submerged *Sphagnum*, *Myriophyllum*, etc. Single record from a pool near L. Garcia, western Tas. 17.0°C, pH 3.1, 80.6 $\mu\text{S cm}^{-1}$.

Comment: The nominate *S. leydigii* is not recorded from Australia. It is distinguished from *S. longispinata* by foot morphology and from the ssp. *longiseta* by its markedly smaller dimensions (body length 110–130 μm ; dorsal spine 90–110 μm ; spine:body ratio 0.8–0.95; toes 10 μm).

Literature: Koste 1978.

Squatinella mutica (Ehrenberg)

FIG. 3:2

Stephanops muticus Ehrenberg, 1832, p. 138.

Squatinella mutica after Harring, 1913, p. 97.

Diagnosis: Caudal margin of dorsal lorica semi-circular, tongue-shaped, three-lobed, with three short spines or truncate (Fig. 3:2d–g). All forms may occur in same population. Foot three-segmented.

Body length 100–226 μm ; headshield width 60 μm ; toes to 30 μm .

Distribution: Europe, N.Z. Rare, from billabongs, ponds or dams; N.S.W., N.T., Tas., Vic. 16.5–24.5°C, pH 3.8–5.3, 45.5–46.2 $\mu\text{S cm}^{-1}$.

Literature: Russell 1961; Koste 1978; Berzins 1982; Koste & Shiel 1987.

Squatinella mutica tridentata (Fresenius)

FIG. 3:5

Stephanops tridentatus Fresenius, 1858, p. 218, Pl. 10, Fig. 11.

Squatinella mutica tridentata after Wiszniewski, 1953, p. 401.

Diagnosis: Posterior lorica oval, terminating in three pointed, elongated spines of variable length.

Resembles *S. rostrum*, but lacks spine at base of toes. Headshield semicircular.

Body length 134–190 μm ; toes 20–30 μm .

Distribution: Ponds and pools, often abundant in *Sphagnum*, pH 4.8–6.2. Rare, Qld, N.S.W., Vic.
Literature: Evans 1951; Koste 1978.

Squatinella rostrum (Schmarda)

FIG. 3:1

Lestron rostrum Schmarda, 1846, p. 20, Pl. 2, Fig. 4.

Squatinella rostrum after Carlin-Nilson, 1939, p. 3.

Diagnosis: Caudal lorica with three long or short pointed processes which arise from narrow bases. Lateral antennae sunken in dorsal lorica margins.

Length 150–217 μm ; toes 24–28 μm ; headshield to 76 μm ; caudal processes to 36 μm ; spine at base of toes to 23 μm .

Distribution: In Aufwuchs (i.e. periphyton attached to submergent stems). Two records only, Brisbane, Qld and from Creswick Ck, Clunes, Vic.

Literature: Thorpe 1887; Koste 1978; Berzins 1982.

Not recorded from Australia:

S. bifurca (Bolton, 1884) in Hudson & Gosse (1886) Europe, Iceland.

S. microdactyla (Murray, 1906). Europe, Newfoundland, in *Sphagnum*.

Genus *Lepadella* Bory de St Vincent

Lepadella Bory de St Vincent 1826, p. 86.

Outline oval, pear-shaped or circular, more or less dorso-ventrally flattened; dorsal and ventral lorica plates firmly joined; deep notch for head and foot; occipital margin of lorica often with granulated collar; head with cap-like plate. Dorsal lorica domed, smooth, with or without keel development, also with several ledges or fillers; lorica margins in some species drawn out into winglike extensions. Head and foot apertures of different shape; differences useful in taxonomy of group. Foot of three flexible segments, one inflexible basal segment. Toes short and pointed or long and needle-like, similar or dissimilar in length, inserted laterally or dorsal-ventrally, in some species completely or partly fused. Corona single ciliary wreath with lateral ciliary tufts and buccal field. Two lateral eye spots, occasionally with separate pigment granules

Fig. 3.1. *Squatinella rostrum* (Schmarda): (a) headshield, dorsal; (b) headshield, ventral; (c) dorsal; (d) lateral antenna; (e) ventral; (f) lateral. 2. *S. mutica* (Ehrenberg): (a) ventral; (b) lateral; (c) dorsal; (d–g) variations in caudal morphology. 3. *S. longispinata* (Tatam): (a) lateral; (b) dorsal; (c) foot, lateral. 4. *S. leydigii longiseta* Pourriot. 5. *S. mutica tridentata* (Fresenius): (a) dorsal; (b) lateral. 1a, b, after Weber (1898); 1c–f, 2a, b, 4a, after Wulfert (1939); 2c–g, after Koste (1978); 3a, after Pejler (1962); 3b, after Stenroos (1898); 3c, after Myers (1942); 4b, after Giffard (1948), 5, after Pourriot (1971). Scale lines 50 μm .

nearby. Dorsal and lateral antennae present, latter generally dorsally situated at level of upper border of foot-opening. Last foot segment usually with caudal antenna. Trophi malleate, uncus with five teeth. Gut with large, sometimes lobed gastric glands. Vitellarium large with eight nuclei. Protonephridia with distinct terminal cells and large bladder. Little known of reproductive cycle. Some males (90–120 µm) are known. Resting eggs, with prickly outer shell, retained in lorica of parent on death.

Lepadella species are benthic, common in billabongs and ponds, but occasionally collected as incursion species in the plankton of reservoirs and rivers, e.g. *L. patella* (Shiel *et al.* 1982). Further details are given by Koste (1978), who notes that all species can be identified from preserved material, although caution must be taken with preservation artefacts, particularly in the case of formalin-preserved specimens. Several of the 45 taxa of *Lepadella* identified from Australia probably are misidentified for this reason. These are considered in the text. Nevertheless, about half of the known species appear to be indigenous; the genus is thus second only to *Brachionus* (Koste & Shiel 1987b) in its complement of endemic taxa.

Three subgenera are recognized on the basis of toe morphology:

- (i) *Lepadella* (toes of equal length, entirely separated);
- (ii) *Heterolepadella* (toes of unequal length);
- (iii) *Xenolepadella* (toes completely or partly fused).

For convenience, the Australian species of the three subgenera are considered separately in the following keys.

Key to species of the genus *Lepadella* (s. str.)

- 1. Dorsal lorica without keel or ribs (may be lightly punctate, but otherwise unornamented).....2
- Dorsal lorica with keel and/or longitudinal ribs or other ornamentation.....17
- 2(1). Lorica length > 3x lorica width, almost cylindrical (Fig. 4:3) *L. angusta* Berzins
- Lorica length < 3x lorica width, ovoid, circular, trapezoidal or rhomboidal.....3
- 3(2). Dorsal lorica cross-section 1/3 of circle to highly-domed hemisphere (Fig. 5:2d).....6
- Dorsal lorica a shallow dome, or dorsoventrally flattened 4
- 4(3). Lorica oval to circular; head aperture notched both dorsally and ventrally (Fig. 6:5a).....
- *L. ovalis* (Müller)
- Lorica 2x wider in posterior third than anterior; dorsal margin of head aperture straight, ventral margin only weakly v-shaped (Fig. 6:3b)..... 5

- 5(4). Ventral lorica with two lateral spines directed forward; toes straight (Fig. 9:2).....
- *L. tana* Koste & Shiel
- Ventral lorica spineless; toes curved.....
- *L. nehoissi* Berzins
- 6(3). Occipital margin of head aperture protruding (Fig. 5:8b)..... 10
- Occipital margin of head aperture concavely notched (Fig. 5:4a).....7
- 7(6). Lorica outline elongate oval to circular (Fig. 5:7a).....8
- Lorica outline rhomboidal (Fig. 5:4a).....
- *L. chengaluthi* Koste
- 8(7). Posterior margin of lorica rounded or truncate, never pointed (Fig. 5:7a).....9
- Posterior margin of lorica tapers to a pointed projection extending beyond base of toes (Fig. 9:7).....
- *L. williamsi* Koste & Shiel
- 9(8). Head aperture ventral sinus with parallel cuticular ribs; dorsally with a wide granulated collar.....
- *L. elliptica* Wulfert
- Head aperture without ribs or dorsal collar.....
- *L. patella* (Müller)
- 10(6). Ventral lorica with longitudinal pleats.....
- *L. triba* Myers
- Ventral lorica unpleated..... 11
- 11(10). Cross-section with rounded head-like lateral margins..... *L. daetylseta* (Stenroos)
- Cross-section lateral margins produced to acute-angled tips.....12
- 12(11). Foot-opening excised dorsally..... 13
- Foot-opening not excised dorsally..... 16
- 13(12). Extremely wide foot-opening, longer than wide; corners with outwardly-curved points.....14
- Foot opening wider than long, no points on corners..... *L. benjamini* Harring
- 14(13). Head aperture ventrally with lateral bifurcate pointed extensions extending beyond dorsal margin.....
- *L. cornuta* (Koste)
- No lateral points on head aperture..... 15
- 15(14). Head aperture with convex dorsal margin; last foot segment < 1/2 toe length.....
- *L. latusimus* (Hilgendorf)
- Head aperture with concave dorsal margin; last foot segment > 1/2 toe length.....
- *L. vitrea* Shephard
- 16(12). Head aperture circular..... *L. upsida* Harring
- Head aperture with deep ventral sinus.....
- *L. ranenburgi* (Léeks)
- 17(1). Lorica outline trapezoidal; lorica ornamented (appears punctate or granulated under LP)..... 18
- Lorica outline circular or oval..... 19
- 18(17). Lateral extensions ("horns") from posterior lorica; rows of tiny rodlike structures cover lorica (Fig. 6:4a).....
- *L. minorii* Koste
- Lateral horns absent; punctiform ornamentation of dorsal and ventral lorica (Fig. 9:5a).....
- *L. tyleri* Koste & Shiel
- 19(17). Lorica outline circular; head aperture circular, ventrally placed; lorica cross-section an inverted saucer (Fig. 6:2)..... *L. lindauii* Koste
- Lorica outline ovoid; head aperture not circular;

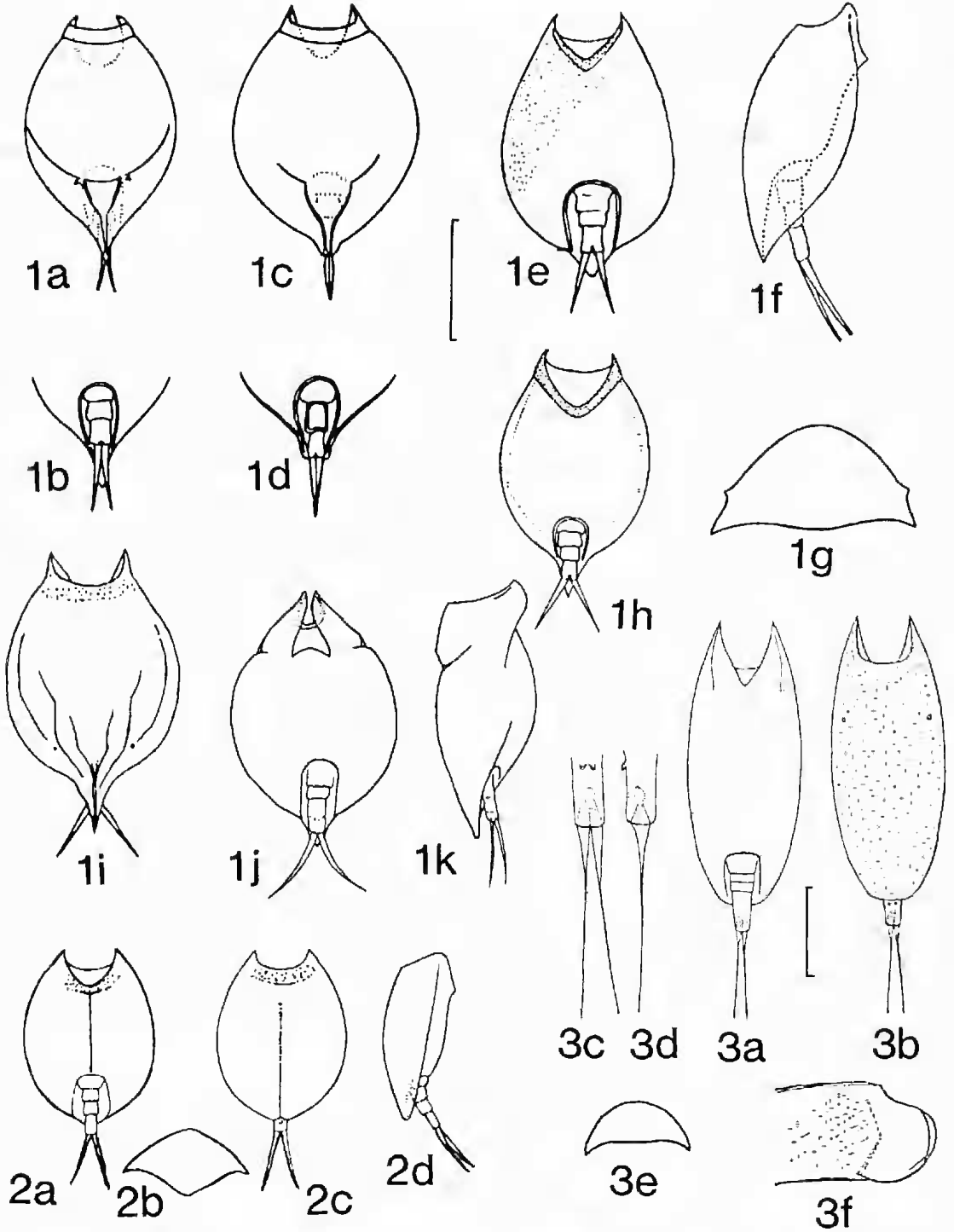


Fig. 4-1. *Lepadella acuminata* (Ehrenberg): (a) dorsal; (b) caudal morphology, ventral; (c) dorsal; (d) caudal morphology, ventral; (e) ventral; (f) lateral; (g) cross-section; (h) ventral; (i) *L. acuminata sexcostata*, dorsal; (j) *L. chorea*, ventral; (k) *L. chorea* lateral. 2. *L. amphitropis* Harring: (a) ventral; (b) cross-section; (c) dorsal; (d) lateral. 3. *L. angusta* Berzins: (a) ventral; (b) dorsal; (c) foot, distal segment, and toes, dorsal; (d) toes, lateral; (e) cross-section; (f) anterior, lateral. 1a-d, h, after Koste & Shiel (1980); 1a, f, g, i, k, after Berzins (1982); 2, after Harring (1916); 3, after Berzins (1960). Scale lines 50 μ m.

- lorica cross-section lightly domed, ribbed or triangular 20
- 20(19). Posterior lorica tapers to an acute point, which may be ridged dorsally
L. acuminata (Ehrenberg)
 Posterior lorica rounded, indented, or concavely notched 21
- 21(20). Dorsal lorica with median keel 24
 Dorsal lorica without median keel 22
- 22(21). Dorsal lorica with open-squared pattern (three rows); occipital margin straight
L. decora Berzins
 Dorsal lorica unpatterned, with 1-4 short ribs over foot-opening 23
- 23(22). 1-3 short ribs at posterior end over foot-opening; cross-section rhombic
L. amphitropis Haring
 4 parallel short ribs over foot-opening; cross-section a shallow dome with lateral concavities of ventral margin (Fig. 8:2C)
L. quadricarinata (Stenroos)
- 24(21). Median keel of dorsal lorica without side ribs 25
 Median keel with 2-3 pairs of side ribs
L. quinquecostata (Lüekes)
- 25(24). Median keel low and wide, bordered by lateral grooves; granulated collar
L. rhomboidea (Gosse)
 Median keel high, triangular, arising from narrow base; no granulated collar. Some forms have fine striped/pustulated lorica surface
L. triptera (Ehrenberg)

NB. Some European forms of *L. triptera* are noted by Koste (1978) to be rhomboidal. Only oval forms are known from Australia.

Lepadella acuminata (Ehrenberg)

FIG. 4:1

Metopidia acuminata Ehrenberg, 1834, p. 210.

Lepadella acuminata after Dujardin, 1841, p. 633.

Lepadella chorea Berzins, 1982, p. 18, Fig. 36.

Diagnosis: Dorsal lorica with two lateral keels; caudal dorsal lorica variable, with small notch or strong elongated spikes, which may show short sharp or blunt ridge dorsally. Nominative sp. with points of dorsal lorica slightly offset laterally.

Length 64-110 μm ; width 42-72 μm ; toe length 18-35 μm .

Distribution: Cosmopolitan between water plants, in littoral of fresh standing and running waters, tolerates slight salinity increases, however prefers acid waters (Koste 1978). Uncommon; pancontinental, 10.0-29.8°C, pH 4.3-7.8, DO 6.1 mg l⁻¹, 28-1020 $\mu\text{S cm}^{-2}$, 8 NTU, Alk. 1.9 mg l⁻¹.

Comments: Several variant forms are known. On present evidence these are not considered of specific status. In *L. acuminata sexcostata* Bartos (Fig. 4:1) the dorsal lorica has six ribs, which run medially

to form an elongated ridge to the end of the lorica. *L. acuminata septemcostata* Berzins probably is an ecotypic variant. *L. chorea* Berzins (Fig. 4:1, k) is inadequately figured, and appears to be a preservation artefact of *L. acuminata*.

Literature: Bartos 1955; Russell 1961; Koste 1978; Shiel & Koste 1979; Green 1981; Berzins 1982; Koste *et al.* 1983.

Lepadella amphitropis Haring

FIG. 4:2

L. amphitropis Haring, 1916, p. 543.

L. amphitropis victoriensis Berzins, 1982, p. 10, Fig. 25.

Diagnosis: Lorica cross-section rhombic due to curvature of the ventral lorica; lorica end with small notch; dorsal lorica end with one to three short ribs.

Length 69-76 μm ; width 54-56 μm ; height to 29 μm ; toes 20-24 μm .

Distribution: In *Sphagnum*, middle Europe and Nth America, Rare; N.S.W., Tas., Vic. 9.5-17.0°C, pH 3.1-5.7, 80.6-98.3 $\mu\text{S cm}^{-2}$.

Literature: Hauer 1958; Koste 1962; Koste & Shiel 1987a.

Comment: A population from the Tarwin R., Vic. designated *Lepadella amphitropis victoriensis* by Berzins (1982) on the basis of the deep sinus on the ventral lorica does not differ in this feature from the nominate species. The measurements of the ssp. are, however, appreciably different: length 86 μm , width 60 μm , head-aperture 20 μm , dorsal sinus depth 8-12 μm , ventral sinus depth 14 μm , foot-opening 18-20x13-16 μm , toe length 15-18 μm . We retain subspecific status for this taxon until the extent of ecotypic variation can be determined.

Lepadella angusta Berzins

FIG. 4:3

L. angusta Berzins 1960, pp. 85-86, Figs 7-12.

Diagnosis: Lorica elongated, ventrally flat, dorsally convex; occipital margin with deep U-shaped dorsal sinus, deeper V-shaped ventral sinus; dorsal lorica sparsely punctate; dorsal pores unusually far forward, in anterior 1/3rd of dorsal lorica; foot groove broad, distally not reaching rounded posterior margin of lorica; foot long, with distal segment longer than two proximal segments combined; terminal segment with two small dorsal projections (Fig. 4:3c, d); toes long, thin, acute, wider proximally.

Length 115 μm (lorica 105 μm), width 46 μm , dorsal sinus 34x18 μm , ventral sinus 34x23 μm , foot groove 25x18 μm , foot and toes 65 μm (terminal segment 16 μm , toes 41 μm).

Distribution: Apparently endemic. Collected in

summer from the Plenty R., Morang, Vic. No other locality known. Ecology unknown. Superficially resembles *L. elliptica* (Fig. 5:7).

Lepadella apside Harring
FIG. 5:1

L. apside Harring 1916, p. 536, Fig. 89:1-3.

Diagnosis: Lorica almost circular; head aperture round, with posterior border drawn downward; toes very short.

Length 70 μm ; width 60 μm ; toes 12 μm .

Distribution: In riparian vegetation. N. America, Asia. Rare: billabongs (N.T.), I. Euramoo (crater lake) (Qld). 28.5°C, pH 5.4, DO 6.2 mg l⁻¹, 23 $\mu\text{S cm}^{-1}$.

Literature: Green 1981; Koste 1981.

Lepadella benjamini Harring
FIG. 5:2

L. benjamini Harring 1916, pp. 548-549, Fig. 93:1-8.

Diagnosis: Lorica outline broadly oval, head aperture more or less tubular, narrow, with ventrally-directed margins; lateral lorica margins in cross-section with bulging, beaded rim, or downturned; foot aperture wider than long; toes long, gently curved ventrally.

Length 112-114 μm ; width 85-100 μm ; height 44-52 μm ; head aperture 32-40 μm ; foot aperture 24x30 μm ; toes 45-48 μm .

Distribution: N. America, S. America (f. *braziliensis* Koste 1972). Rare: I. Boort, Vic., N.T. billabongs. 20.0-24.5°C, pH 6.3-7.4, DO 5.1-8.8 mg l⁻¹, 42-1500 $\mu\text{S cm}^{-1}$.

Literature: Koste 1981.

Lepadella chengalathi Koste & Shiel
FIG. 5:4

L. chengalathi Koste & Shiel, 1980, p. 138, Figs 7 a-d.

Diagnosis: Rhomboidal lorica with rounded corners, widest in first third; head opening small, not deflected ventrally; foot-opening semicircular at widest point of caudal boundary of dorsal lorica; dorsal lorica weakly arched towards interior; three flexible foot-articulations, distalmost slender and elongated; toes symmetrical, long, needle-like, straight (Fig. 5:4b); lorica cross-section shows highly vaulted dorsal lorica with slender downward-drawn lateral wings; ventral plate with delicate double convex keel (Fig. 5:4d).

Length 135-140 μm (lorica 96 μm); width 92 μm ; height 48 μm ; head-opening width 28 μm ; foot-opening 28x28 μm ; distal foot segment 19-20 μm ; toes 33-36 μm .

Distribution: Endemic, only known locality I. Boort, Vic. 23.5°C, pH 7.9, DO 6.0 mg l⁻¹, 420 $\mu\text{S cm}^{-1}$, 67 NTU.

Lepadella cornuta nom. nov.
FIG. 5:3

Lepadella latusinus f. *mucronata* Koste, 1981, p. 119, Fig. 14a, b.

non *L. mucronata* Schmarida, 1859, p. 57, Pl. 13, Fig. 20. non *Metopidia mucronata* Daday, 1908, p. 30.

Diagnosis: General posterior outline of lorica resembles *L. latusinus*, with extremely wide foot-opening; in *L. cornuta* opening wider in proportion to lorica width, i.e. body slightly more elongate; caudal margin lightly concave dorsally, ventrally with v-shaped sinus flanked by distinctive pointed lateral projections extending beyond dorsal margin; points are bifurcate in lateral view (Fig. 5:3 inset), with upper longer tips reflexed ventrally over shorter tooth.

Lorica length 110 μm ; width 62 μm ; foot-opening width 40 μm ; toe length 32 μm .

Distribution: Endemic, only record from Nakeen Billabong, Magela Creek, N.T. 29.9°C, pH 5.47, DO 5.45 mg l⁻¹, 44 $\mu\text{S cm}^{-1}$, alkal. 2.6 mg l⁻¹.

Lepadella dactyliseta (Stenroos)
FIG. 5:5

Metopidia dactyliseta Stenroos, 1898, p. 165, Fig. 3:1.

Lepadella dactyliseta after Harring, 1916, p. 547, Figs 92:1-3.

Diagnosis: Caudal margin of dorsal lorica flat, even or convex; ventral margin with variable sinus (cf. *L. latusinus*); lorica cross-section always shows very pronounced dome; toes relatively short.

Length 93-100 μm ; width 60-66 μm ; height 40 μm ; toes 24-32 μm .

Distribution: Cosmopolitan in algal-rich standing waters, also lake litorals. Rare, Vic. 8.5-27.0°C, pH 7.0-7.6, DO 7.0-11.2 mg l⁻¹, to 575 $\mu\text{S cm}^{-1}$, 21-52 NTU.

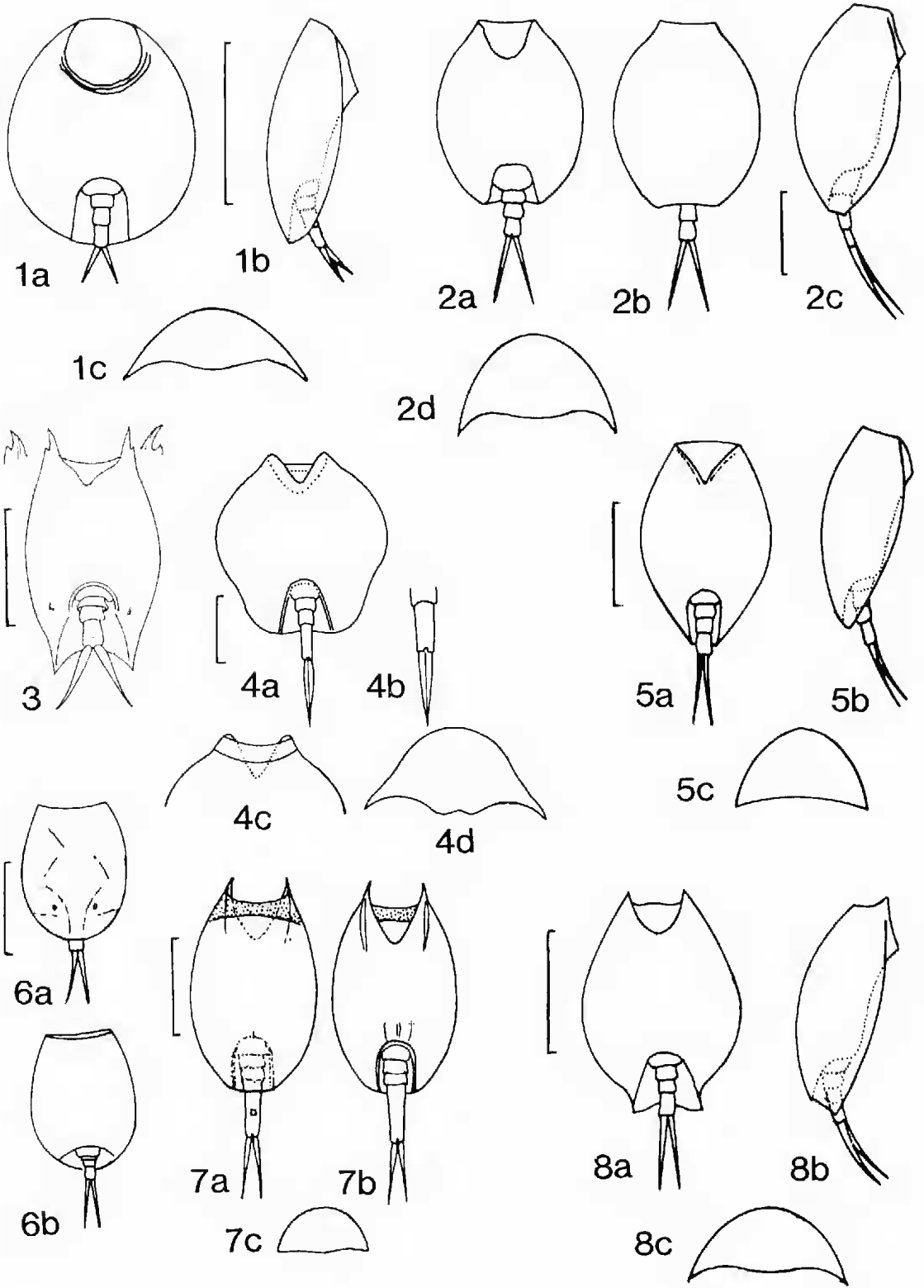
Literature: Koste & Shiel 1980; Berzins 1982.

Lepadella decora Berzins
FIG. 5:6

L. decora Berzins 1982, p. 11, Figs 2a, b.

Diagnosis: Occipital margins nearly straight; dorsal lorica with open-squared pattern, arranged in three rows; robust pores on last third of dorsal lorica; ventral lorica slight; foot-opening wider than long, occupies whole posterior margin; toes straight, sharp.

Length 70 μm ; width 52-54 μm ; head-opening 35



μm ; foot-opening 12×30 – $32 \mu\text{m}$; toes 24 – $26 \mu\text{m}$.

Distribution: Only known locality Loddon R., Victoria. Ecology unknown.

Literature: Berzins 1982.

Comment: Inadequately figured in Berzins (1982). We have reproduced Berzins figure, which does not show the patterning or pores described above. We have not encountered the species, however on the basis of the above description regard it as valid.

Lepadella elliptica Wulfert

FIG. 5:7

L. elliptica Wulfert 1939, p. 609, Fig. 21.

Diagnosis: Elongated lorica, hemispherical in cross-section (cf. *L. angusta*); head aperture with shallow U-shaped dorsal sinus, deep V-shaped ventral sinus, latter with accompanying parallel-bordered lateral cuticular pleats; distal foot-segment conspicuously long, tapering slightly to base of toes; toes relatively long, curved ventrally.

Length 108 – $115 \mu\text{m}$; width $70 \mu\text{m}$; distal foot-segment $28 \mu\text{m}$; toes 20 – $22 \mu\text{m}$.

Distribution: Sporadic in littoral decomposition zone. Known only from a billabong of the Magela Ck, Jabiluka, N.T. 25.5°C , pH 6.2 , DO 2.9 mg l^{-1} , $62 \mu\text{S cm}^{-1}$.

Literature: Koste 1981.

Lepadella latusinus (Hilgendorf)

FIG. 5:8

Metopidia solidus latusinus Hilgendorf, 1899, p. 131, Fig. 1115d.

Lepadella latusinus after Hanning, 1913, p. 63.

Diagnosis: Lorica broadest in middle, tapers slightly to each end; cross-section vaulted hemisphere; occipital margin cow-like, protruding; head aperture relatively small; extremely wide foot-opening, small spikes at margins hooked dorsally upwards.

Lorica length 80 – $92 \mu\text{m}$; width to $64 \mu\text{m}$; height $35 \mu\text{m}$; head aperture width $24 \mu\text{m}$; toes 24 – $28 \mu\text{m}$.

Distribution: In subtropical and tropical shallow waters (but recorded from Mt Cook, N.Z.), warm stenotherm. Rare: N.T. 24.0 – 27.0°C , pH 4.5 – 6.3 , DO 5.1 mg l^{-1} , $42 \mu\text{S cm}^{-1}$.

Comment: A variant described by Koste (1981) from Nankeen Billabong, N.T. as *L. latusinus* cf. *visenda* (Fig. 6:1a) had features of *L. latusinus* and *L.*

visenda Myers (Fig. 6:1b). Only one individual was encountered, insufficient material for further analysis.

Literature: Myers 1934; Russell 1945; Koste 1978;

Lepadella lindauai Koste

FIG. 6:2

L. lindauai Koste 1981, pp. 109–110, Fig. 2.

Diagnosis: Wide egg-shaped lorica, occasionally with almost circular outline; head aperture ventral, nearly circular, at times bordered around lower part by cuticular ribs; foot opening parabolic to elliptical; caudal margin rounded or lightly indented. Lorica flat. Dorsal lorica in cross section slightly arched with wide raised hump, which in posterior $\frac{1}{3}$ rd, accompanied by two converging pleats, carries flat keel, terminating in fine point reaching caudal margin. Lateral antennae papillae small on end of oblique lorica fold (Fig. 6:2a). Sensory pit present on distal foot segment.

Lorica length $80 \mu\text{m}$; width $68 \mu\text{m}$; head aperture $22 \mu\text{m}$; lorica height $20 \mu\text{m}$; foot aperture $23 \mu\text{m}$; toes $12 \mu\text{m}$.

Distribution: Only known localities Mombasa, Kenya and Winnmurra billabong, Magela Creek near Jabiluka, N.T. 28.5°C , pH 5.4 , DO 6.2 mg l^{-1} , $23 \mu\text{S cm}^{-1}$, alkal. 2.7 mg l^{-1} .

Lepadella minorui Koste

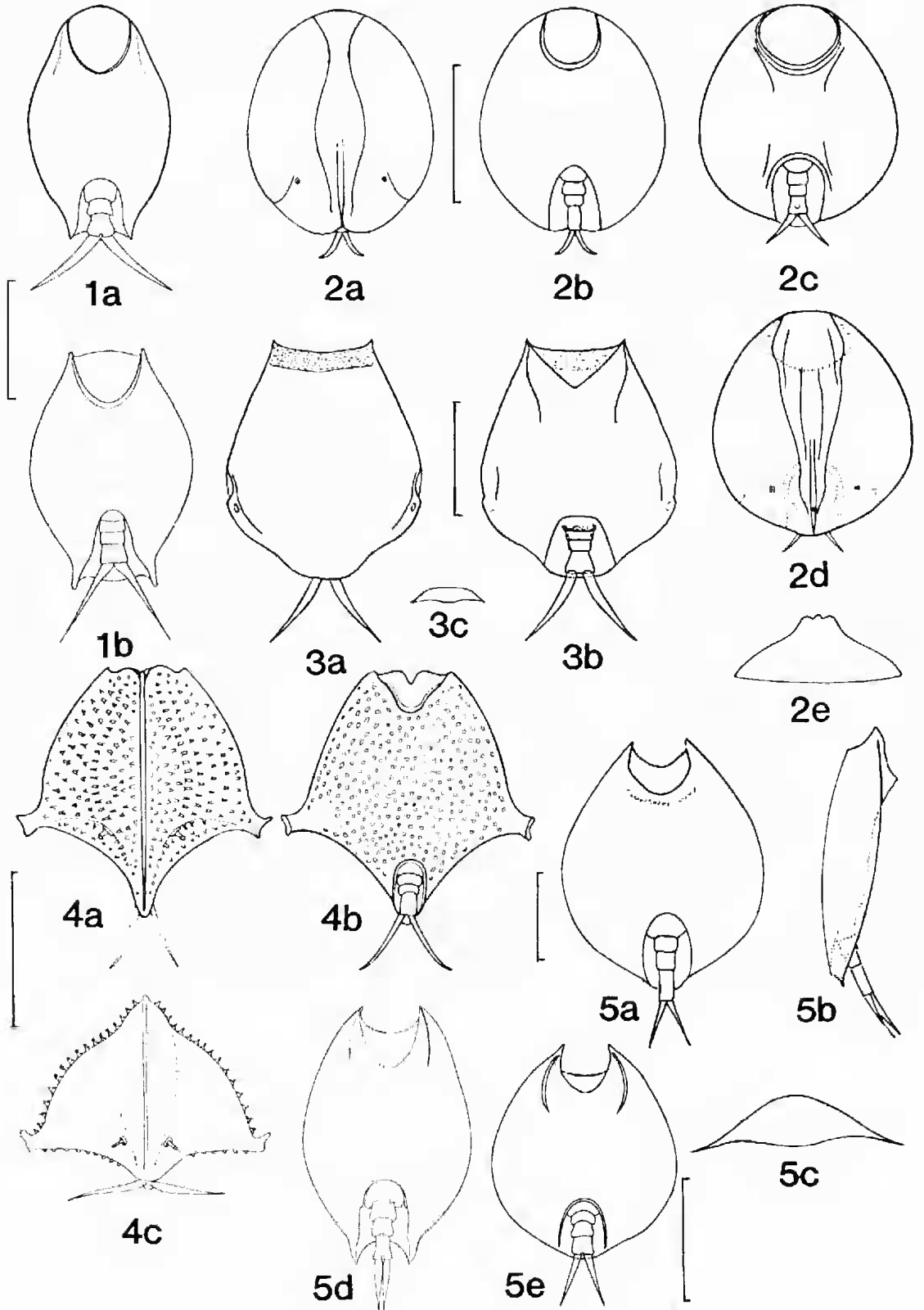
FIG. 6:4

L. minorui Koste, 1981, pp. 110–113, Fig. 3.

Diagnosis: Lorica outline in upper part trapezoidal with wings (ductlike, terminally concave (Fig. 6:4a, b)); lorica tapers symmetrically from wings, ending in pointed protrusion covering foot-opening; head aperture (ventral) smoothly indented, dorsally with median notch; thin keel runs from notch to posterior lorica margin; ventral plate flat, with robust head-like structures (unpatterned); dorsal lorica covered with 3 – $6 \mu\text{m}$ long rods in rows parallel to margins outside, and with keel on inner rows. Rods sit on circular bases. Lateral antennae dorsal, located approximately level with anterior margin of foot-opening, with pistil-like papillae; foot 3-segmented; toes lightly curved ventrally, pointed.

Lorica length 72 – $80 \mu\text{m}$; width 76 – $80 \mu\text{m}$; height $48 \mu\text{m}$; toe length $24 \mu\text{m}$; head aperture width $24 \mu\text{m}$, depth $12 \mu\text{m}$; foot-opening width $16 \mu\text{m}$.

Fig. 5:1, *Lepadella upsida* Hanning: (a) ventral; (b) lateral; (c) cross-section. 2, *L. benjamini* Hanning: (a) ventral; (b) dorsal; (c) lateral; (d) cross-section. 3, *L. cornuta* (Koste), ventral. 4, *L. chengalathi* Koste & Shiel: (a) ventral; (b) distal segment of foot and toes; (c) occipital margin, dorsal, (c) cross-section. 5, *L. thalysiseta* (Stentros): (a) ventral; (b) lateral; (c) cross-section. 6, *L. decora* Berzins: (a) dorsal; (b) ventral. 7, *L. elliptica* Wulfert: (a) dorsal; (b) ventral; (c) cross-section. 8, *L. latusinus* (Hilgendorf): (a) ventral; (b) lateral; (c) cross-section. 1, 2, 5, 8, after Hanning (1916); 3, after Koste (1981); 4, after Koste & Shiel (1980); 6, after Berzins (1982); 7, after Wulfert (1939). Scale lines $50 \mu\text{m}$.



Distribution: Endemic, Leichhardt and Winmulla billabongs, Magela Creek near Jabuluka, N.T. 28.5–30.1°C, pH 5.4–5.5, DO 5.5–6.3 mg l⁻¹, 23–58 µS cm⁻¹, alkal. 2.7–2.9 mg l⁻¹.

Lepadella nevoissi Berzins
FIG. 6:3

L. nevoissi Berzins 1960, p. 83, Figs 1–3.

Diagnosis: Outline of body broadly ovate, greatest width slightly posterior to middle of body; lorica strongly dorso-ventrally flattened, without ridges; anterior dorsal margin straight, ventral margin with wide V-shaped sinus and short fold present on each side; lorica rounded posteriorly. Sinus and fold slightly behind the middle of body, on each side of lorica, with corresponding pores on dorsal side; foot groove nearly as long as wide; foot rather short, terminal segment longer than first and second segments combined; toes relatively long, divergent, pointed at apex.

Total length 105–108 µm (lorica 78–81 µm); width of anterior lorica 63–66 µm; ventral sinus 11–13 µm deep; foot groove 18–19x12 µm; foot 14–16 µm; toes 30 µm.

Distribution: Endemic, King Parrot Creek, near Kinglake West, Vic.

Comment: Resembles *L. monodi* Berzins from Senegal, Africa, but differs in the form of the lateral sinus and the pores for lateral antennae on the margin.

Lepadella ovalis (Müller)
FIG. 6:5

Brachionus ovalis Müller, 1786, p. 345, Fig. 49:1–3.
Lepadella ovalis after Ehrenberg, 1830, p. 45, Fig. 7:4, non *Metopidia ovalis* Anderson & Shephard, 1892, p. 78 (see *L. vitrea*).

Diagnosis: Lorica outline oval to circular; wide space between internal organs and lorica margins; ventral lorica nearly flat; lorica at rim thinly tapered; narrow striated area at outer margin from head aperture to foot-opening; outline of foot-opening variable; gastric glands often lobed and long-stalked. Juvenile animals sometimes have caudal notch dorsally over foot-opening. Males known. Resting egg shell covered with robust, lightly curved spines.

Lorica length 90–170 µm; width 70–140 µm;

height 25–30 µm; toe length 22–36 µm; foot opening to 48 µm deep, 32 µm wide.

Distribution: Cosmopolitan, between macrophytes in benthos of fresh and saline waters. Uncommon; pancontinental. Ecotypes described from Australian waters include a form from the Magela Creek, N.T. (Fig. 6:5d) and a minute form from L. Dulyverton, Tas (Fig. 6:5e). 8.2–24.0°C, pH 5.8–7.7, 273–3330 µS cm⁻¹.

Literature: Koste 1978, 1981; Shiel & Koste 1985; Koste & Shiel 1986a.

Lepadella patella (Müller)
FIG. 7:1

Brachionus patella Müller, 1786, p. 341, Fig. 48:15–19.
Lepadella patella after Bory de St Vincent, 1826, p. 86.

Diagnosis: Lorica outline ovoid to circular; dorsal lorica domed, without wings; ventral lorica flat, occasionally with somewhat overhanging margins; wide lorica forms more domed in cross-section than narrower forms (Wulfert (1960) described flat and domed forms from *Sphagnum*); variable foot opening (Hauer (1962) found caudal corners of foot-opening extended into spines, while one specimen described by Wulfert *loc. cit.* had almost circular foot-opening); occasionally, dorsal lorica adjacent to foot-opening has weakly distinguishable folds. Male known.

Length 120–145 µm; lorica length 70–110 µm; width 65–90 µm; length:width ratio mostly <1.2; toe length 20–35 µm; male 110–120 µm.

Distribution: Cosmopolitan, euryopic in fresh and saline waters. Common; pancontinental. Ecotypic variants are known from N.T. (Fig. 7:1e) and Tas. (Fig. 7:1g). 10.0–24.5°C, pH 3.9–8.8, DO 7.8–11.6 mg l⁻¹, 9.2–6600 µS cm⁻¹, 3.0–262 NTU.

Literature: Koste 1978, 1981; Shiel & Koste 1985.
Comment: Several recognized subspecific variants of *L. patella* are recorded from Australian waters. The status of these taxa may change with detailed systematic work;

Lepadella patella biloba Hauer
FIG. 7:2

Lepadella patella biloba Hauer, 1958, pp. 27–28, Fig. 2:14.
L. patella f. *biloba* (Hauer) by Koste, 1978, p. 185.

Diagnosis: Lorica outline resembles *L. patella*, however differs from f. typ. in three features: lateral corners of foot-opening reflexed dorsally (Fig. 7:2d);

Fig. 6c), (a) *Lepadella latusinus* cf. *visenda*, ventral; (b) *L. visenda* Myers, ventral; 2, *L. lindau* Koste: (a) N.T. form, dorsal; (b) ventral; (c) Mombasa form, ventral; (d) dorsal; (e) cross-section. 3, *L. nevoissi* Berzins: (a) dorsal; (b) ventral; (c) cross-section. 4, *L. minorai* Koste: (a) dorsal; (b) ventral; (c) cross-section. 5, *L. ovalis* (Müller): (a) ventral; (b) lateral; (c) cross-section, (d) N.T. form; (e) Tas. form la, 2, 4, 5d, after Koste (1981); 1b, after Myers (1934); 3, after Berzins (1960); 5a-c, after Haring (1916); 5e, after Shiel & Koste (1985). Scale lines 50 µm.

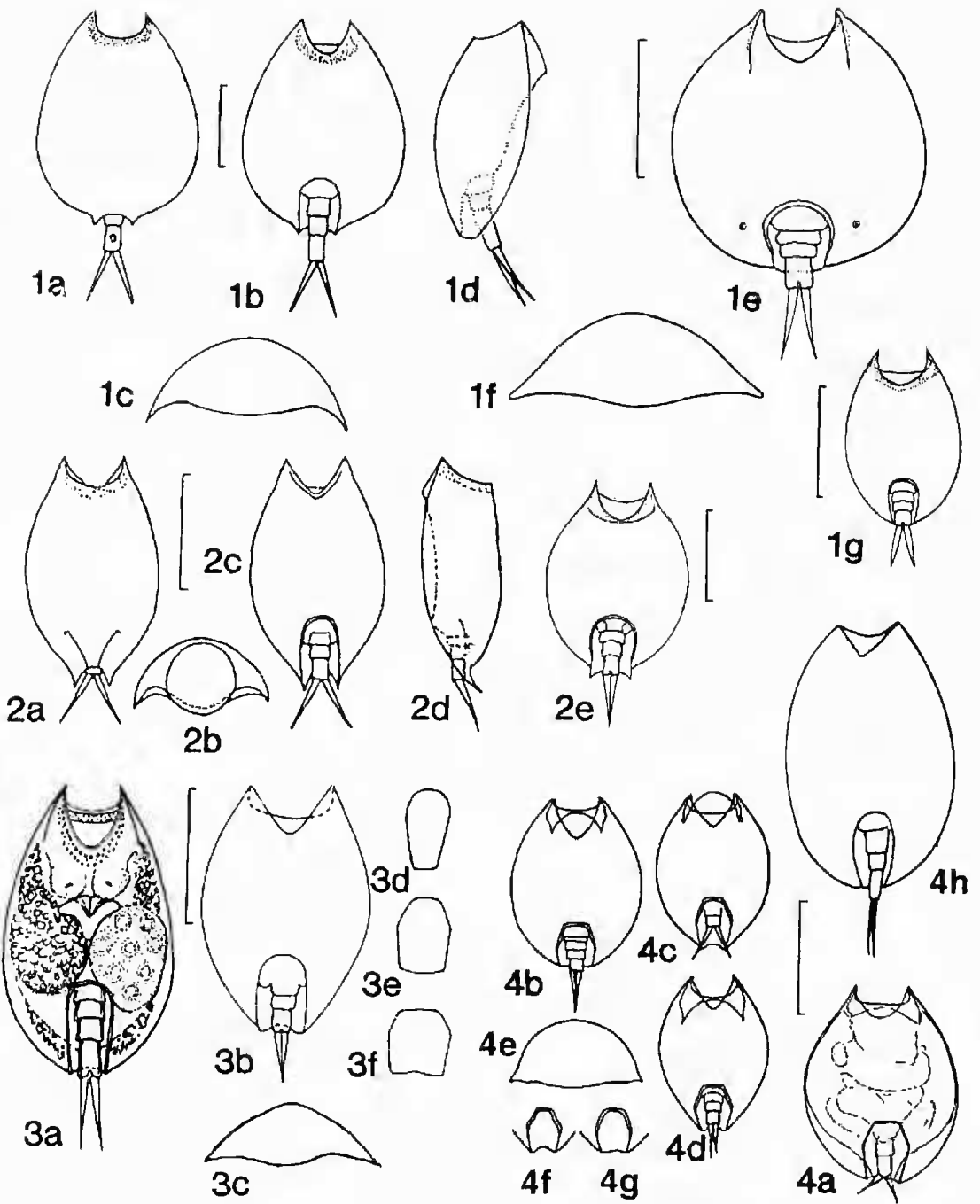


Fig. 7: 1. *Lepudella patella* (Müller): (a) dorsal; (b) ventral; (c) lateral; (d) cross-section; (e) N.T. form, ventral; (f) cross-section; (g) Tas. form, ventral. 2. *L. patella biloba* Hauer: (a) dorsal; (b) cross-section; (c) ventral; (d) lateral; (e) Tas. form, ventral. 3. *L. patella oblonga* (Ehrenberg): (a) ventral; (b) ventral; (c) cross-section; (d-f) variations in foot-opening morphology. 4. *L. patella similis* (Luicks): (a) ventral; (b-d) different lorica forms, ventral; (e) cross-section; (f-g) foot-opening, ventral; (h) *L. buangensis* Berzins, ventral. 1a-d. after Harring (1916); 1e, f. after Koste & Shiel (1980); 1g, 2e, after Koste & Shiel (1986); 2a-d, 4b-g, after Hauer (1958); 3a, c, after Wulfert (1939); 3b, d-f after Björklund (1972); 4h, after Berzins (1982). Scale lines 50 μ m.

ventral lorica with lateral concavities, side margins deflected downwards (Fig. 7:2b); two short cuticular folds of caudal dorsal lorica.

Length 80–107 μm ; width 59–64 μm ; height 36 μm ; toes 19–25 μm .

Distribution: Europe. Rare: Tas., Vic., southwest W.A. 11.8–24.0°C, pH 3.5–7.9, 18.3–2130 $\mu\text{S cm}^{-1}$.

Literature: Koste *et al.* 1983; Shiel & Koste 1985.

Lepadella patella oblonga (Ehrenberg)

FIG. 7:3

Squamula oblonga Ehrenberg, 1834, p. 220.

Lepadella oblonga (Ehrenberg) after Harring, 1913, p. 64.

Lepadella patella f. *oblonga* after Wulfert, 1960, p. 285, Fig. 24.

Diagnosis: Distinguished from *L. patella* only by relatively low lorica height and narrow head aperture. Lorica outline mostly elliptical.

Lorica length 80–110 μm ; width 50–70 μm ; length:width ratio >1.5; toes 20–25 μm .

Distribution: In fresh and brackish water pools, often sympatric with the nominate species and *L. patella similis*. Björklund (1972) demonstrated biometrically distinguishable populations, however intergrades with *L. patella* typ. occur.

Only Australian record from Sheepwash Billabong, near Yea, Vic. 17.iv.76 (Shiel unpubl.). 19.9°C, pH 7.2, DO 8.5 mg l^{-1} , 85 $\mu\text{S cm}^{-1}$, Secchi transparency 80 cm.

Literature: Koste 1978.

Lepadella patella similis (Lucks)

FIG. 7:4

Metopidia similis Lucks, 1912, p. 119, Fig. 39.

Lepadella similis (Lucks) after Hauer, 1925, p. 17.

L. patella var. *similis* after Remane, 1929, p. Fig. 113A–F.

L. buangensis Berzins, 1982, p. 11, Fig. 5.

Diagnosis: Lorica outline elliptical; foot-opening with reinforced upper arch (Fig. 7:4 f, g), mostly hexagonal with angled edges and base straight to indented. Not reliable taxonomic character because of variability in foot-opening. Distinguished from *L. patella* (s. str.) by lorica length:width ratio (>1.2) and overall smaller habit.

Length 68–85 μm ; width 49–60 μm ; toes 17–21 μm .

Distribution: Between macrophytes, detritus, in psammon and rock pools; fresh, brackish and salt; pH to 10 (Koste 1978). Single record from Australia (as *L. buangensis* Berzins), but recognizable as a preservation artefact of *L. patella similis*, Mt Donna Buang, Vic.

Lepadella ptilota Berzins

FIG. 8:1

L. ptilota Berzins, 1960, pp. 83–85, Figs 4–6.

Diagnosis: Body ovoid in outline; ventral surface slightly medially convex, dorsal surface very strongly so; dorsal median line with sharp, uneven longitudinal ridge; frontal margin dorsally convex, with blunt projection in the middle; ventrally with rounded sinus; laterally, lorica enlarged with three pairs of thin, transparent lamellary projections; lorica prolonged posteriorly to rounded lobe; cross section somewhat triangular.

Length 72–75 μm ; width 60–67 μm ; ventral sinus depth 8 μm ; length of foot groove 12–15 μm ; toes 12 μm .

Distribution: Endemic. Only known locality Creswick Creek near Clunes, Victoria. Ecology unknown.

Comment: Resembles *L. triptera* (Ehrenberg) but differs in the form of the frontal margin of the lorica, the sharp dorsal ridge, and the presence of lateral cuticular projections [termed "flappers" in the original description although they have no muscular contact].

Lepadella quadricarinata (Stenroos)

FIG. 8:2

Metopidia quadricarinata Stenroos, 1898, p. 165, Fig. 3:2.

Diagnosis: Dorsal lorica with four short ribs over foot-opening; posterior end tapering to short tongue; ventral lorica flat; foot opening variable.

Lorica length 81–92 μm ; width 61–72 μm ; height to 34 μm ; toe length 20–26 μm .

Distribution: Littoral, between macrophytes, pH 6.2–10.2 (Koste 1978). Only record that of Berzins (1982) from Coghill's Creek near Tourello, Vic. *L. q. sexcarinata* (Klement), recorded from the same locality, may be an ecotype.

Literature: Koste 1978.

Lepadella quinquecostata (Lucks)

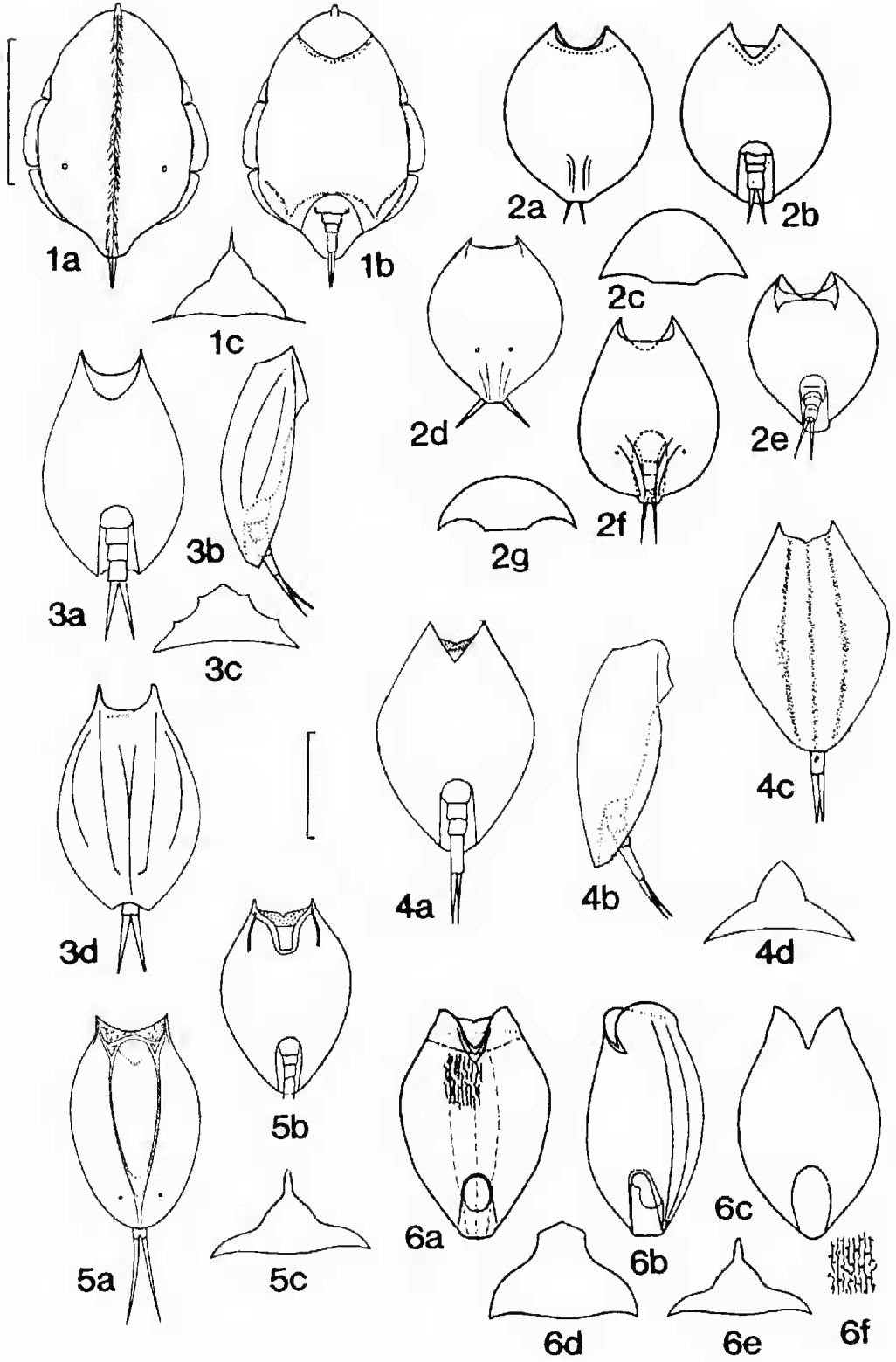
FIG. 8:3

Metopidia quinquecostata Lucks, 1912, p. 126, Fig. 47.

Diagnosis: Lorica pyriform, narrowing towards head; dorsal lorica with median low keel which begins as widely separated ridges behind collar of head aperture; two or three pairs of side ribs; distinctive cross-section (Fig. 8:3c); lorica end variable, sometimes with short ridge; foot-opening variable.

Lorica length 92–112 μm ; width 60–70 μm ; toe length 22–30 μm .

Distribution: Cosmopolitan in littoral, often



collected in *Sphagnum*, pH 4.5–6.7, temperature to 30°C (Koste 1978). Single record: dam near Chillagoe, Qld.

Lepadella rhomboides (Gosse)

FIG. 8:4

Metopidia rhomboides Gosse in Hudson & Gosse, 1886, p. 108, Fig. 25:10.

Lepadella rhomboides after Hanning, 1913, p. 65.

Diagnosis: Dorsal lorica with moderately high, more or less arched median keel, bounded by lateral grooves; anterior margin width $\frac{1}{4}$ lorica length; dorsal sinus broadly U-shaped; ventral sinus V-shaped; dorsal aperture of head-opening with collar, which can be bordered by cuticular thickening; foot opening narrow, U-shaped with parallel sides; distal foot segment long (cf. *L. elliptica*); toes short ($< \frac{1}{4}$ body length) slightly decurved, tapering to points.

Lorica length 110–120 μm ; width 55–88 μm ; toe length 20–28 μm .

Distribution: Cosmopolitan in periphyton, pH tolerant. Rare: N.S.W., N.T., Tas., Vic. 10.5–30.7°C, pH 4.7–7.9, DO 4.6–6.0 mg l^{-1} , 23–750 $\mu\text{S cm}^{-1}$, to 67 NTU, alkal. 2.7–2.9 mg l^{-1} .

Comment: Two variants are known from Australia, described elsewhere as ssp., form or var.: *L. rhomboides haueri* (Wulfert) (Fig. 8:5) from a stock dam south of Burnie, Tas. (16.5°C, pH 4.7, 42 $\mu\text{S cm}^{-1}$) and *L. rhomboides carinata* (Donner) (Fig. 8:6) from the Broken R. at Benalla, Vic. (27.0°C, pH 7.6, DO 7.0 mg l^{-1} , 52 $\mu\text{S cm}^{-1}$).

Literature: Kutikova 1970; Koste 1978; Koste *et al.* 1983; Koste & Shiel 1986a.

Lepadella rottenburgi (Lucks)

FIG. 9:1

Metopidia rottenburgi Lucks, 1912, p. 127, Fig. 48a, b. *L. rottenburgi* after Hanning 1913, p. 65.

Diagnosis: Side margins of lorica cross-section extend to pointed tips below level of median ventral bulge; head aperture dorso-ventrally deep, only ventral sinus; dorsal margin straight, without sinus; foot-opening variable. Resembles *L. dactyliseta*. Can be confused with *Colurella* spp. in lateral view.

Lorica length 75 μm ; width 50 μm ; toes 25–28 μm . **Distribution:** Isolated occurrences in *Sphagnum* and

peat swamps. Only record Riddell's Creek, Sunbury, Vic.

Literature: Koste 1978; Berzins 1982.

Lepadella tana Koste & Shiel

FIG. 9:2

Lepadella tana Koste & Shiel, 1987, p. 102, Fig. 19.

Diagnosis: Lorica broadly ovoid, ventral lorica flat, dorsal medially convex in median cross-section; dorsal margin of head-opening almost straight, ventral margin with weak V-shaped sinus; fold behind middle of body on ventral surface; with pointed, slightly curved spine on either side, directed apically; foot-opening broad; toes relatively long, straight, sharply pointed.

Lorica length 79 μm ; width (medially) 61 μm ; anterior width 29 μm ; foot-opening 18x18 μm ; toes 29 μm ; lateral spine length 18 μm .

Distribution: Endemic, only known locality L. Pedder, Tasmania. 16.5°C, pH 5.3, 46.2 $\mu\text{S cm}^{-1}$.

Comment: Resembles *L. nebaissi*, a Victorian endemic (Fig. 6:3), however the latter has ventral folds (no spines), and differs in foot and toe morphology.

Lepadella triba Myers

FIG. 9:3

Lepadella triba Myers, 1934, pp. 4–5, Figs 10–12.

Diagnosis: Lorica elongated; cross-section shallow, evenly arched dorsally; dorsal margin of head-aperture almost straight, ventrally broadly V-shaped; no stippled collar; ventral lorica with distinctive *Euchlanis*-like slightly elevated mid-section (Fig. 9:3c), lateral margins run to head aperture or diverge to side apices; foot opening flaring; distal foot segment approximately $\frac{1}{2}$ toe-length; toes long, tapering to slender drawn-out tips.

Lorica length 71–80 μm ; width 42–45 μm ; ventral sinus depth 12 μm ; foot opening depth 20 μm ; foot length 26 μm ; distal segment 14 μm ; toes 30–33 μm .

Distribution: North America. Single record from Qld (Berzins 1982) needs verification.

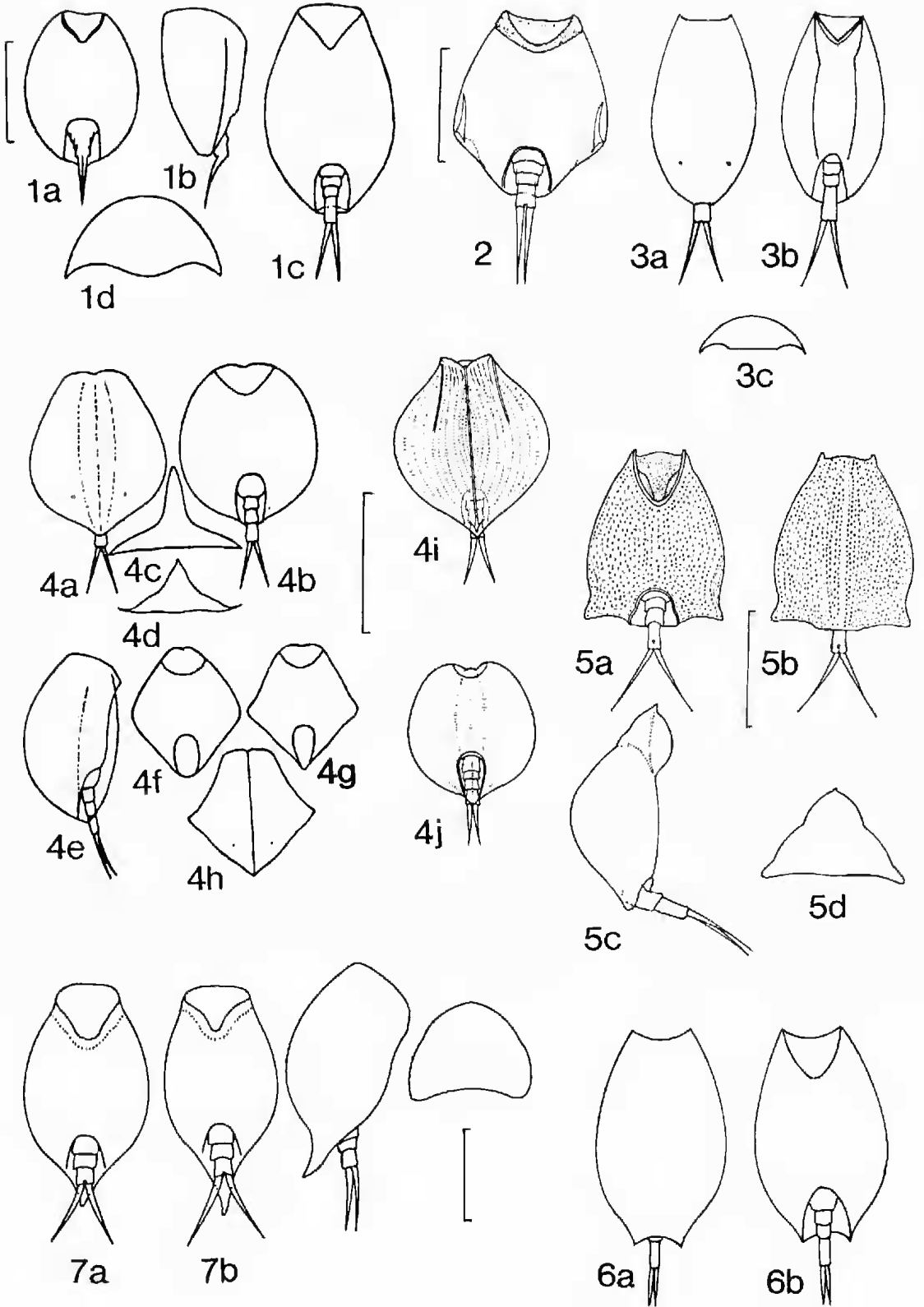
Lepadella triptera (Ehrenberg)

FIG. 9:4

Metopidia triptera Ehrenberg, 1830, pp. 74–83.

Lepadella triptera Ehrenberg, 1832, p. 72.

Fig. 8:1, *Lepadella pilota* Berzins: (a) dorsal; (b) ventral; (c) cross section. 2, *L. quadricarinata* (Stenroos): (a) dorsal; (b) ventral; (c) cross-section; (d) dorsal; (e) ventral; (f) dorsal; (g) cross-section. 3, *L. quinquecostata* (Lucks): (a) ventral; (b) lateral; (c) cross-section; (d) dorsal. 4, *L. rhomboides* (Gosse): (a) ventral; (b) lateral; (c) dorsal; (d) cross-section. 5, *L. rhomboides haueri* (Wulfert): (a) N.T. form, dorsal; (b) European form, ventral; (c) cross-section. 6, *L. rhomboides carinata* (Donner): (a) ventral; (b) lateral; (c) ventral; (d) cross-section spec. a; (e) cross-section spec. c; (f) lorica surface morphology. 1, after Berzins (1960); 2a–c, f, 5b, d, after Bartos (1959); 2d, g, after Pejler (1962); 2e, after Björklund (1972); 3, 4, after Hanning (1916); 5, after Koste (1981); 6, after Donner (1943). Scale lines 50 μm .



Diagnosis: Lorica outline variable; circular to rhombic according to Koste (1978). Dorsal lorica vaulted, with high, somewhat protruding median keel; head aperture with shallow U-shaped sinus ventrally, usually slight median notch dorsally; lorica surface may be finely striped (Fig. 9:4i) with small rounded protrusions, most, however, are smooth.

Lorica length 58–65 μm ; width 50–57 μm , toes 13–22 μm .

Distribution: Cosmopolitan in fresh and brackish waters, and on muddy littorals. Rare: N.S.W., N.T., Qld, Tas., Vic. 12.4–20.0°C, pH 4.8–7.7, 17–3330 $\mu\text{S cm}^{-1}$.

Literature: Shiel & Koste 1979; Koste 1981; Berzins 1982.

Lepadella tyleri Koste & Shiel

FIG. 9:5

Lepadella tyleri Koste & Shiel, 1987a, p. 37, Figs 3, 4.

Diagnosis: Rigid lorica of trapezoidal outline; cross-section nearly triangular; dorsal plate with median keel; dorsal and ventral plates finely granulated; head aperture lightly convex dorsally, deep V-shaped sinus ventrally, with lateral lamella; caudal lorica with slight constriction above blunt lateral corners; foot-opening broadly flared; three foot segments, distal with caudal antenna; toes very thin, elongated, pointed.

Total length 123–125 μm ; lorica length 78–80 μm ; greatest width 58 μm ; height 36 μm ; head aperture width 21 μm , depth 22 μm ; foot opening 18x18 μm ; distal foot segment 12 μm ; toes 32 μm .

Distribution: Endemic; only known locality a stock dam south of Swansea, east coast of Tasmania, 13.0°C, pH 6.0, 390 $\mu\text{S cm}^{-1}$, 82 NTU.

Lepadella vitrea (Shephard)

FIG. 9:6

Metopidia ovalis Shephard in Anderson & Shephard, 1892, p. 78, Fig. 6, 6a. (on *M. ovalis* (Muller, 1786))

M. vitrea Shephard, 1911, p. 55.

Lepadella vitrea after Harring, 1913, p. 65.

Diagnosis: Ovoid, transparent lorica, tapering to each end from widest part posterior to midline; head aperture slightly convex dorsally, without

sinus, ventrally with deep, broadly elliptical sinus; dorsal margin of foot opening convex between lateral points of slightly outcurved caudal lorica projections; ventral foot opening deep 1/2-ellipse; distal foot segment almost twice length of proximal segments, more than half length of toes; toes short, tapering to pointed tips.

Length 125 μm ; width 56 μm . [No other measurements given in the original description, however from Fig. 6 in Anderson & Shephard (1892), on the basis of their length/width measurements, the following are estimated: head aperture 23 μm wide x 20 μm deep; foot opening 20 μm wide x 22 μm deep; distal toe joint 12 μm ; toes 17 μm .]

Distribution: Subsequent to the original find (Brighton, Victoria), *L. vitrea* was recorded from South Westland, N.Z. (Russell 1954). Dimensions were slightly different (114 μm long, toes 20 μm), with "a series of dots round the lateral edge of the dorsal plate". *L. vitrea* is possibly more widespread. **Comment:** *L. vitrea* was synonymised with *L. latusinus* by later reviewers (e.g. Koste 1978), however can be distinguished from the latter by more elongated lorica (length:width ratio 2.2 vs <1.5 in *L. latusinus*), absence of cowl-like head aperture, elongated distal foot-segment and markedly shorter toes.

Lepadella williamsi Koste & Shiel

FIG. 9:7

Lepadella williamsi Koste & Shiel, 1980, pp. 138–139, Fig. 8.

Diagnosis: Smoothly oval, highly vaulted lorica, with ventrally-directed head-opening; dorsal lorica tapers caudally to variable-length laterally curved point; foot-opening narrow, ending at base of dorsal lorica projection; three foot segments of similar length; long, dorso-laterally curved sharp toes.

Lorica length 112–116 μm ; width 60–64 μm ; height to 56 μm ; head aperture 33–36x28–30 μm ; caudal lorica projections 19–28 μm ; foot opening 17–20x19–20 μm ; distal foot segment 10 μm ; toe length 36–40 μm .

Distribution: Kuala Lumpur, Malaysia, and Jabaloka, N.T. only known localities. 25.5°C, pH 6.2, DO 2.9 mg l^{-1} , 62 $\mu\text{S cm}^{-1}$, 5 NTU.

Fig. 9:1, *Lepadella rottenburgi* (Lucks): (a) ventral; (b) lateral; (c) ventral; (d) cross-section. 2, *L. jana* Koste & Shiel, ventral. 3, *L. tribo* Myers (a) dorsal; (b) ventral; (c) cross-section. 4, *L. triptera* (Fjurenberg): (a) dorsal; (b) ventral; (c) cross-section, (d) cross-section; (e) lateral; (f-h) different lorica forms, ventral; (i) Tas. form, ventral; (j) 2nd Tas. form, ventral. 5, *L. tyleri* Koste & Shiel: (a) ventral; (b) dorsal; (c) lateral; (d) cross-section. 6, *L. vitrea* (Shephard): (a) dorsal; (b) ventral. 7, *L. williamsi* Koste & Shiel: (a, b) two morphs, ventral; (c) lateral; (d) cross-section. 1a, b, after Culling (1939); 1c, d, after Bantos (1959); 2, 4i, j, after Koste & Shiel (1986); 3, after Myers (1934); 4a-h, after Harring (1916); 5, after Koste & Shiel (1987a); 6a, orig.; 6b, after Shephard (1911); 7, after Koste & Shiel (1980). Scale lines 50 μm .

**Key to species of the genus *Lepadella*
(*Heterolepadella*)**

1. Loricæ oval.....2
 Loricæ rhomboidal.....3
 2(1). Head aperture with V-shaped dorsal and ventral
 sinuses.....*L. (H.) heterodactyla* Fadeev
 Head aperture with only a ventral sinus, dorsal
 margin straight.....*L. (H.) apsicora* Myers
 3(1). Loricæ with posterolateral pointed spurs; foot groove
 with lateral pointed projections.....
*L. (H.) ehrenbergi* (Perty)
 Lateral wings of lorica and posterior margins of foot
 groove rounded.....*L. (H.) heterostyla* Murray

Lepadella (Heterolepadella) apsicora Myers
 FIG. 10:1

Lepadella apsicora Myers, 1934, pp. 5, 7, Figs 16–18.

Diagnosis: Lorica oval; cross section shallow, evenly arched dorsally; dorsal anterior margin nearly straight, ventral margin with deep V-shaped sinus; stippled collar present; foot groove wide, flared posteriorly; distal foot joint 2x length of combined first and second joints; foot twisted, left toe lies beneath right; toes asymmetric, right 2x length of left.

Lorica length 80 µm; width 65 µm; ventral sinus depth 18 µm; anterior points 28 µm; foot groove 21 µm; foot 30 µm; distal segment 20 µm; right toe 30 µm; left 14 µm.

Distribution: North America. Two records from Australia: L. Boort, central Victoria, and Winmurra Billabong, Magela Creek, N.T. 23.5°C, pH 5.4–7.9, DO 6.0–6.2 mg l⁻¹, 23–750 µS cm⁻¹, 67 NTU, alkal. 2.7 mg l⁻¹.

Literature: Koste & Shiel 1980; Koste 1981.

L. (H.) ehrenbergi (Perty)
 FIG. 10:2

Notozonia ehrenbergi Perty, 1850, p. 20.

Metopidia ehrenbergi after Jennings, 1894, p. 26.

Lepadella ehrenbergi after Haring, 1913, p. 63.

Diagnosis: Lorica rhombic, with posterolateral margins produced to triangular, dorsally ridged spurs reflexed upwards in cross-section (Fig. 10:2c); smaller pointed spurs on each side of foot groove; stippled collar on ventral plate, with less obvious dorsal stippling; foot groove ½ length of lorica, rounded anteriorly, flaring slightly posteriorly; foot stout, ½ length of lorica; distal foot joint longest; toes long, asymmetric, taper evenly.

Lorica length 70–95 µm; width 70–90 µm; toe length 27–32 µm and 19–27 µm.

Distribution: Cosmopolitan in periphyton, *Utricularia*

and moss. Rare; in billabongs and vegetated lake margins in N.S.W., N.T., Qld, Vic. 24.0–29.2°C, pH 6.3–7.5, DO 5.1–8.0 mg l⁻¹, 42–85 µS cm⁻¹, 6 NTU.

Literature: Shiel & Koste 1979; Koste & Shiel 1980; Green 1981; Koste 1981.

L. (H.) heterodactyla Fadeev
 FIG. 10:3

L. (H.) heterodactyla Fadeev, 1925, p. 73, Pl. 1, Fig. 8.

Diagnosis: Lorica oval; dorsal and ventral margins of head aperture with deep, almost triangular sinuses; last foot segment longer than preceding segments.

Lorica length 106–113 µm; width 70–75 µm; distal foot segment 22–23 µm; toes 23–30 and 20–25 µm.

Distribution: Europe, S. America (Amazonia). Single record, L. Boort, central Vic. 20.0 °C, pH 7.4, DO 8.0 mg l⁻¹.

Literature: Kutikova 1970; Koste 1978; Koste & Shiel 1980.

L. (H.) heterostyla (Murray)
 FIG. 10:4

Metopidia heterostyla Murray, 1913, p. 459, Pl. 19, Fig. 6a–c.

Diagnosis: Lorica rhombic; lateral wings rounded rather than pointed (cf. *L. ehrenbergi*), with tips more or less deflected dorsally; ventral lorica wider than dorsal in region of head aperture; stippled collar present.

Distribution: Probably cosmopolitan in littoral zones, stagnant waters. Rare: N.S.W., Tas., Vic. 10.0–23.5°C, pH 5.8–7.9, DO 6.0–9.8 mg l⁻¹, 80–750 µS cm⁻¹, 2–67 NTU.

Literature: Koste 1978; Shiel & Koste 1979; Koste & Shiel 1980.

Not recorded from Australia:

L. (H.) cyrtopus (Haring), Eastern Europe, N. and Central America.

A single free-living species of the subgenus *Lepadella (Xenolepadella)* is recorded from Australia. In view of the preferred habitat of most of the other known species of the genus, i.e. the branchial chambers of a range of crustaceans, it is likely that other species occur here but have been overlooked.

Lepadella (Xenolepadella) monodactyla Berzins
 FIG. 10:5

Lepadella monodactyla Berzins, 1960, pp. 5, 6, Figs 8–11.

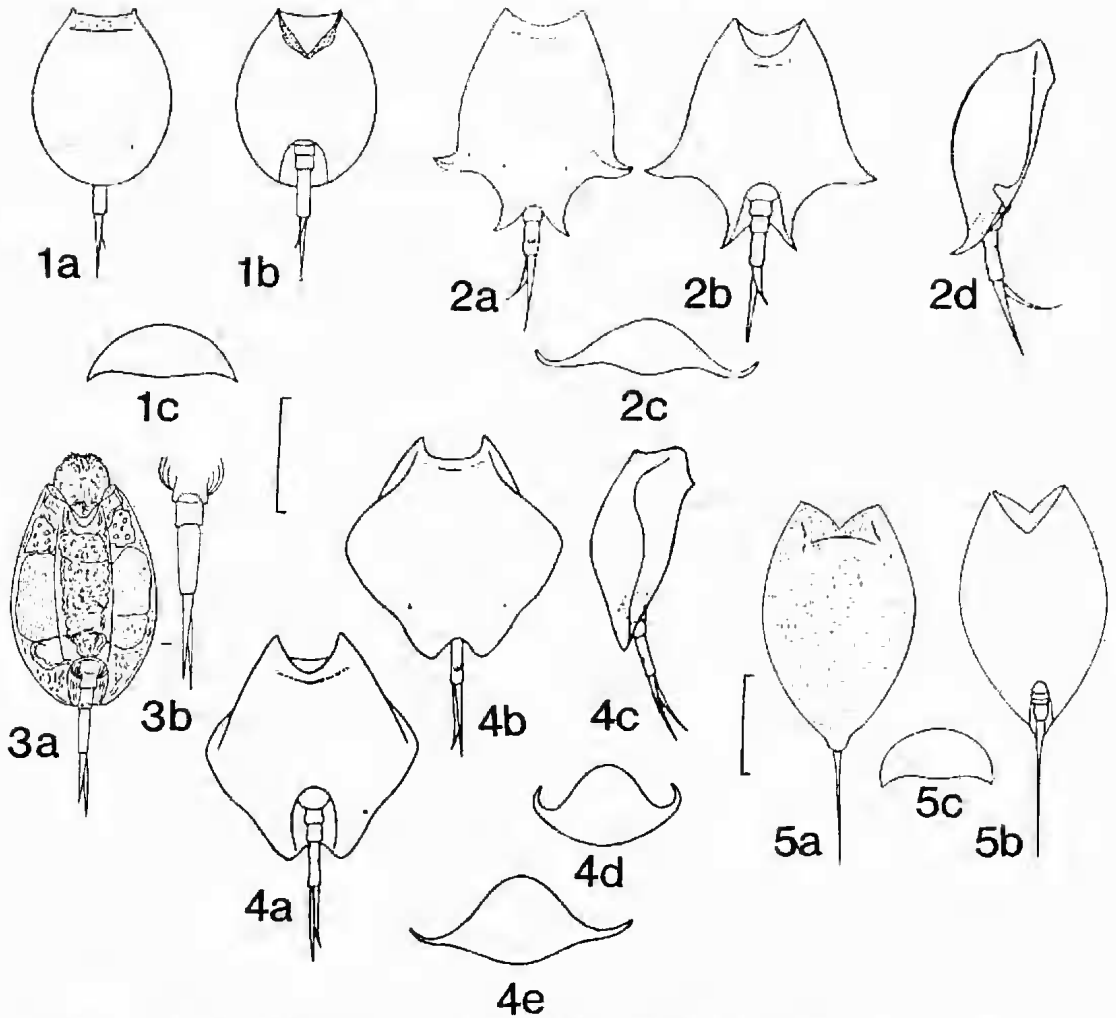


Fig. 10:1, *Heterolepadella apsicora* Myers: (a) dorsal; (b) ventral; (c) cross-section; 2, *H. ehrenbergi* (Perty): (a) dorsal; (b) ventral; (c) cross-section; (d) lateral. 3, *H. heterodactyla* Fadeev: (a) ventral; (b) toe detail. 4, *H. heterostyla* Murray: (a) ventral; (b) dorsal; (c) lateral; (d, e) different cross-sections; 5, *Xenolepidella monodactyla* Berzins: (a) dorsal; (b) ventral; (c) cross-section. 1, 2, after Harring (1916); 3, after Kutlkova (1970); 4, after Harring (1916); 5, after Berzins (1960). Scale lines 50 μm .

Diagnosis: Lorica outline elliptical; dorsal lorica arched, punctate or lined; ventral plate with light bulge medially, otherwise unstructured; head aperture with V-shaped dorsal and ventral sinuses.

Total length 170 μm ; lorica length 127 μm ; width 77 μm ; foot-opening 31x10 μm ; toe 57 μm .

Distribution: Madagascar, variants known from Brazil. Single record, billabong, Jabiluka, N.T. 25.5°C, pH 6.2, DO 2.9 mg l⁻¹, 62 $\mu\text{S cm}^{-1}$.

Literature: Koste 1978; Koste & Shiel 1980.

Not recorded from Australia:

L. (X.) astacicola Harring, *L. (X.) borealis* Harring, *L. (X.) branchicola* Hauer, *L. (X.) haueri*

Rodewald, *L. (X.) lata* Wisniewski, *L. (X.) parasitica* Hauer, *L. (X.) pygmaea* (Gosse). See Koste 1978:198-200 for details).

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